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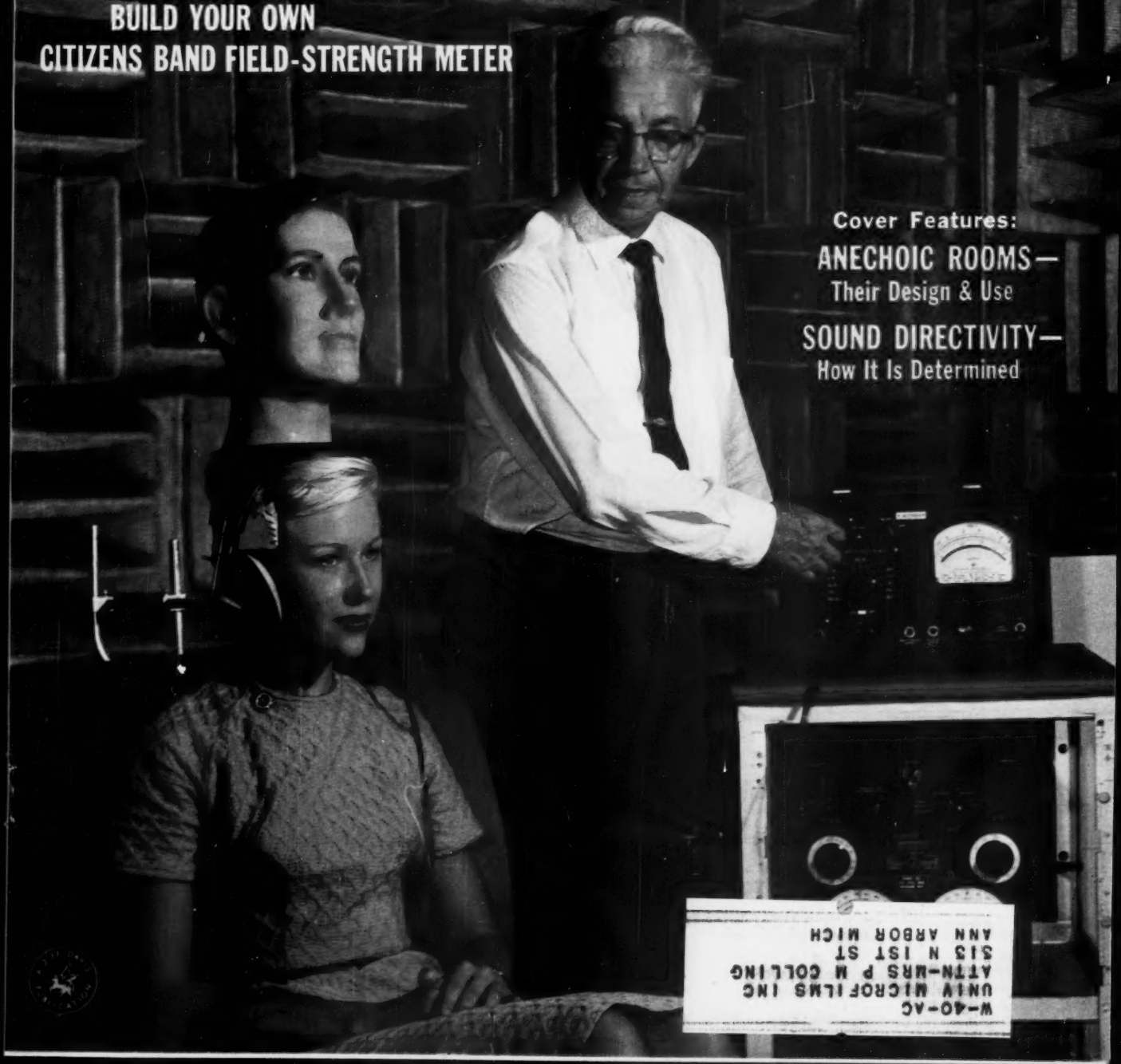

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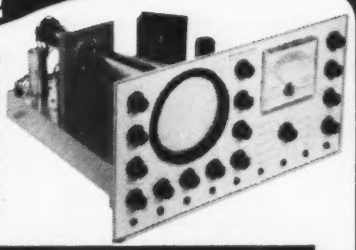

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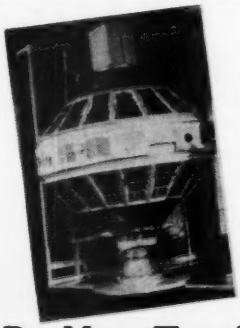

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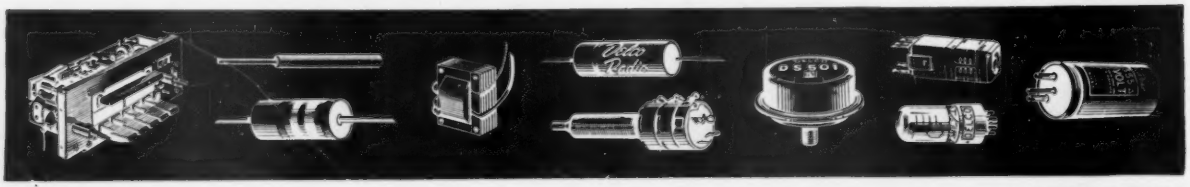

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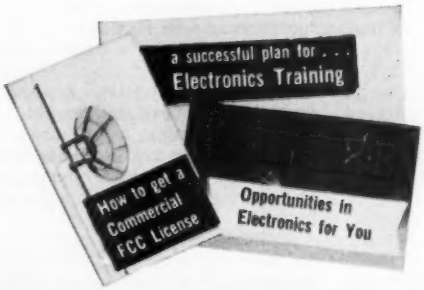

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TECHNICIANS & TEST EQUIPMENT

TODAY with over 700 TV stations, 3500 AM stations, and some 900 FM stations sending signals to more than 51 million TV sets and 155 million radios, the consumer aspects of the industry are scarcely "overshadowed" by growth elsewhere. Servicing and maintaining these millions of receivers involves the efforts of about 125,000 technicians.

These men are of crucial importance to the test equipment manufacturer. Last year alone, they spent over $1-billion on replacement parts and test equipment, and this figure has been rising from year to year.

As the TV era mushroomed, more test equipment was bought for several reasons. To begin with, the work force engaged in consumer service continued to expand rapidly. Every new entrant was a user of equipment and old instruments were becoming obsolete.

The annual service bill still shows an increase from year to year, and will continue to do so for the foreseeable future. But of the billion dollars spent on "replacement parts and test equipment," one may wonder how much, at this time, is still being spent on the latter.

There is no doubt that there has been a certain amount of leveling off. Although new entrants continue to penetrate the field, much of the basic work force has been stabilized, and manufacturers of test instruments must look towards not only expansion in allied fields, but to improved present designs, to continue to prosper in step with the rest of the electronics industry.

There are many directions in which he may strike out. For one thing, he can take a clue from many of his customers, our readers, who are expanding into other fields. Many industries have found the service of high-fidelity equipment lucrative in addition to or instead of TV service. Others are exploring the installation and maintenance of mobile communications equipment, automotive or marine. In the Citizens Band alone we now have over 110,000 authorized operators registered after only two years.

Each of these new fields requires that the technician have certain equipment, whether it be a distortion analyzer, a field-strength meter, or an r.f. wattmeter, that he did not have to have for radio and TV service. The manufacturer must be alert to these new needs.

He must also be willing to show ingenuity in the continued improvement of conventional equipment. Many manufacturers have achieved success simply by streamlining or remodeling older types of equipment. A multi-purpose probe that, with the simple manipulation of a switch or the probe head, provides a variety of different accessory functions for meter or scope, is one example. A single unit takes the place of a number of different accessories.

The punch-card type of tube tester is another example of this alertness. In essence, these units did not provide any technical functions that were beyond the scope of their predecessors. However, their convenience, especially important in an era when the customer likes to push the buttons himself, revived sales in a category of instruments that had been around for many years. Compactness to permit portability for use on outside calls, recombination of test functions in single instruments (like the tube-transistor-diode tester whose meter movement can also be used for conventional circuit measurements, through externally available leads), still hold out much unrealized promise.

Without a doubt, the future looks bright considering that the population will increase by 30 million by 1969 and the rate of new home construction will be 1.5 million per year by 1965. This will mean more radio and television sets. In fact, all facets of electronics, including those where test equipment is employed, will rise sharply. Not only is population growth usually a business barometer, but we should not overlook the many exciting new developments that are now in our laboratories. It will not be long before we will have new marketable products, such as ultrasonic dishwashers and washing machines, new types of electronic air filters, electroluminescent lighting, FM multiplexing—all for the home. This means more work for our service technicians and, to test equipment manufacturers, it means that not only more equipment will be needed, but in many cases it means new types will be required.

Another avenue which presents a sales market is the industrial electronic field. It is a new market, and it is rather difficult to analyze and therefore predict the growth pattern in the years ahead. At the present time, most of the technicians who install and service industrial equipment are employed by the original equipment manufacturer, but the trend is definitely towards independent service departments in non-electronic plants.

As more and more automatic control equipment is installed, obviously, more and more service departments must be formed.

Although the greater part of the test equipment required is of highly specialized nature, much of the equipment will be similar to that used by our consumer radio and TV technicians. [30]

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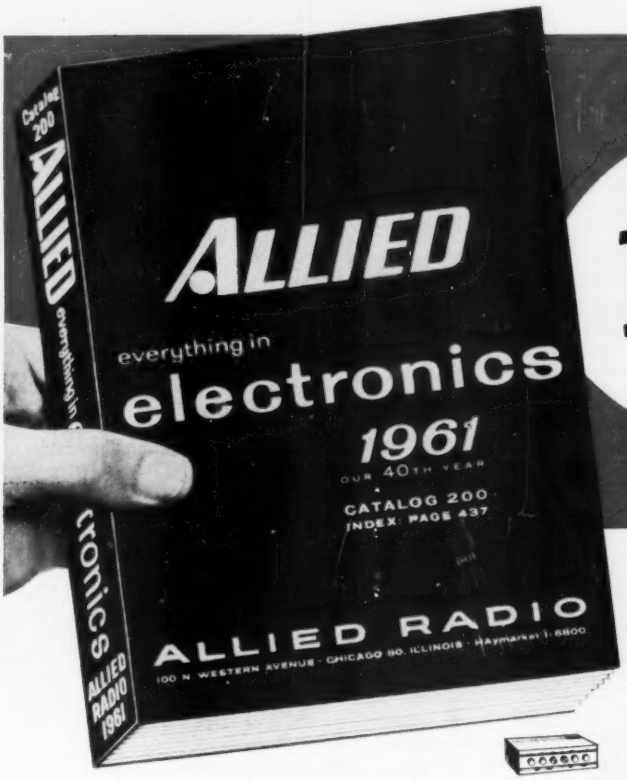

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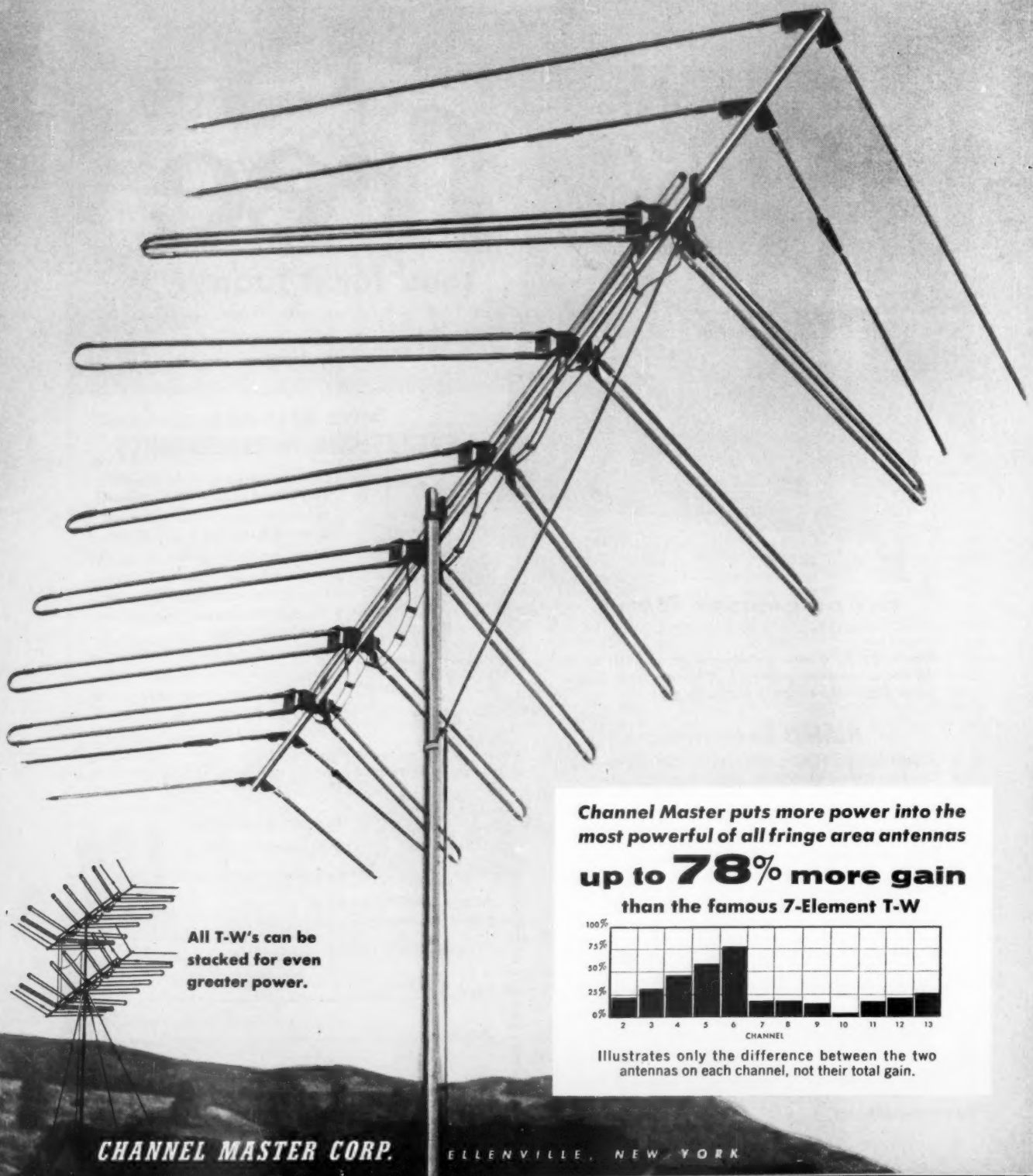

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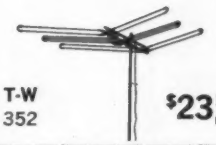

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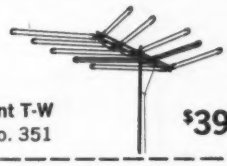

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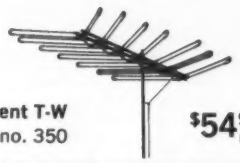

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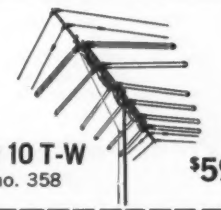

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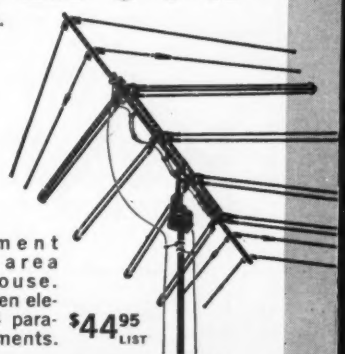

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PHILADELPHIA "RETAIL" PACT

To the Editors:

I have just been looking over the August, 1960 issue, and saw an item labeled "Philadelphia 'Retail' Pact" under Service Industry News.

This general subject has been on my mind for a long time. I am an electronics experimenter and a radio amateur and occasionally do part-time work in radio-TV shops in the area. When I am doing such work, I have an immediate source for any parts I may need for my many projects at wholesale prices. However, when I am not working in a shop, I get my parts from a mail-order house or from the local distributors. As it takes a few weeks to get them through the mail, the distributor is more convenient.

But, I certainly would not pay retail prices at a distributor's and have a service shop pocket my hard earned money without earning it. The trouble with most service shops is that they have inflated egos and think that they are the only ones in the industry. What about all the physicists, engineers, and radio amateurs that have a definite interest in and knowledge of electronics, but are not employed in the field? Are they to be expected to buy all their parts retail? If they are to be made to buy all their parts retail, the service shops should buy their equipment, literature, and parts retail also.

Since I have worked in shops before, I know that they have a hard time of it, especially with all the sets that are using the newer techniques. But this is no excuse for the "retail" pact. They must realize that they are not the only users of individual parts. The pact in Philadelphia is not only immoral, but is probably illegal. It amounts to a tax by the service shops because there is money received where no service is rendered. I hope we see no more of this sort of thing in the future.

ROBIN WADLEIGH
Vienna, Virginia

Reader Wadleigh's viewpoint concerning wholesale-retail distributor agreements in electronics is not without merit. So far as we know, the agreement in the Philadelphia area, like similar agreements reached in other parts of the country, gives due consideration to individuals like him.

Radio amateurs and other non-servicing personnel who have certain qualifications are given special consideration, but the privilege of buying at wholesale prices is not extended to the lay public. In some areas, those who wish to buy at discount must make application for a discount card to the distributor setting forth his position or the other grounds on which he bases such privilege. Cards of one color are issued to service dealers and technicians, while cards of other colors are issued to hams and other categories.

The basic problem is not necessarily the service dealer himself, but the peculiar pattern of distribution that has grown up in electronics. In most other fields, distributors prominently display "wholesale only" signs and live up to this commitment carefully. For example, we suggest you try buying drugs and pharmaceuticals, which carry much higher markups than electronic components, direct from a jobber. It is virtually impossible to do so. In some parts of the country it is illegal for distributors to sell directly to the public at least at the same price that he sells to dealers.

Basically, the service industry is suffering no loss to the radio amateur and has no complaint in that direction. However, the service dealer is deeply concerned where his own customer can walk directly into a distributor and pay exactly the same price for any item that the dealer must himself pay.—Editors.

* * *

CHECKING CB FREQUENCY

To the Editors:

I was very glad to see you publish an article on checking CB frequencies ("What's Your Citizens Band Frequency," August, 1960 issue). But, when I read the article, I was very disappointed. The method outlined by Author Stoner for using the BC-221 is very inaccurate and can only lead to highly erroneous readings. While the BC-221 can be used for accurate frequency measurements of CB transmitters, the method outlined has proved to be a pitfall for many unsuspecting servicemen, and has been the cause of many published warnings about the use of surplus frequency meters.

I had my own *Johnson* "Viking Messenger" transceiver checked by such a method, and was told I was on frequency on all 5 channels. When I had the opportunity of checking the transceiver myself a few days later on a *Hewlett-Packard* 220 mc.-counter, I found I was off frequency as much as 3500 cycles on four of the five channels! As a result, I did a little checking and discovered there *are* ways of using the BC-221 for reasonably accurate measurements.

Let me get specific about my objections to Don Stoner's article. On page 37 of the August issue, he states, "Although these frequency meters only go to 20 mc., they will generate super-accurate signals on the Citizens Band by using the second harmonic of a 13.5-mc. signal." The range of all models of the BC-221 is 125 to 250 kc. (low band) and

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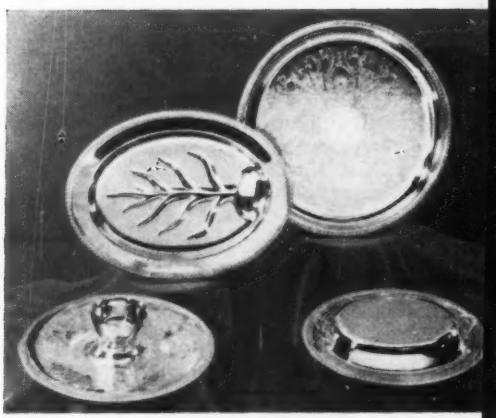

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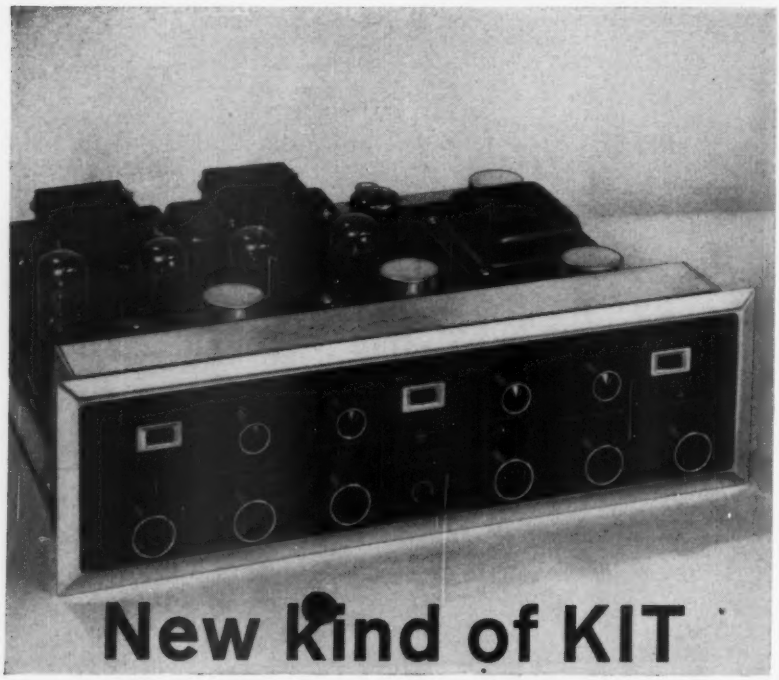

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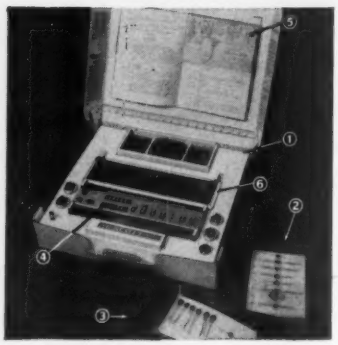

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2000 to 4000 kc. (high band). The 13.5-mc. signal referred to is actually a 4th harmonic of the fundamental in the high band of the instrument. At CB frequencies, this would be the 8th harmonic of the fundamental.

Further down the same page, Stoner states, "By making the graph large, it is possible to interpret to 100 cycles." The smallest vernier division on the BC-221 is 1/10th of a dial division. In most cases the dial readings on the high band average about 2.3 dial divisions per kc. at the fundamental. At the 8th harmonic in the CB band, 1/10th of a dial division would represent roughly 350 cycles. No matter how large a graph is constructed, it is obvious that the determining factor for close reading is not the graph, but the scale of the BC-221.

Nothing is mentioned in the article of the basic accuracy of the BC-221. Like any piece of test equipment, this one is not perfect. According to the Army Technical Manual covering the BC-221 (TM 11-300), the maximum error at 4000 kc. is 1355 cycles; at 2000 kc., 985 cycles. Assuming for the sake of argument that this maximum error is 1000 cycles at 3375 kc., at the 8th harmonic (27 mc.) the maximum error would be 8000 cycles! According to the technical manual, actual tests show that in most cases the average error can be assumed to be no greater than 50 per-cent of the values given. Even so, this is 4000 cycles at 27 mc.—hardly a "standard" against which to measure frequencies which must be ± 1350 cycles. Further, there would be additional errors introduced by graph-making, and graph-reading as required in Stoner's technique.

Fortunately, however, all is not lost. There are methods of using the BC-221 which will provide accuracies of 0.0025 per-cent or better. They require no alteration to the basic BC-221 circuit. These methods include building a voltage-regulated, remote power supply for the BC-221 (a relatively simple job), providing a means of calibrating the BC-221 internal crystal standard (such as a receiver equipped with an "S" meter and capable of receiving WWV on 5 or 10 mc.), and using the additive method of frequency reading when checking transmitters on the bench. In addition, a "rough" method, also ± 0.0025 per-cent, can be used for checking signals on the air, as received from other transmitters. All these methods have been carefully checked with the *Hewlett-Packard* counter, and have been found accurate for every one of the six BC-221's we have tested.

R. L. CONHAIM, 19W7577
Dayton, Ohio

Several of our readers have pointed out that the average error of a BC-221 that meets its own specs is around .015 per-cent. However, it is still possible to use this instrument to check CB transmitters employing the techniques mentioned above and further covered below by Author Stoner in his reply to Reader Conhaim's letter.—Editors.

Dear Mr. Conhaim:

As you and other readers have pointed

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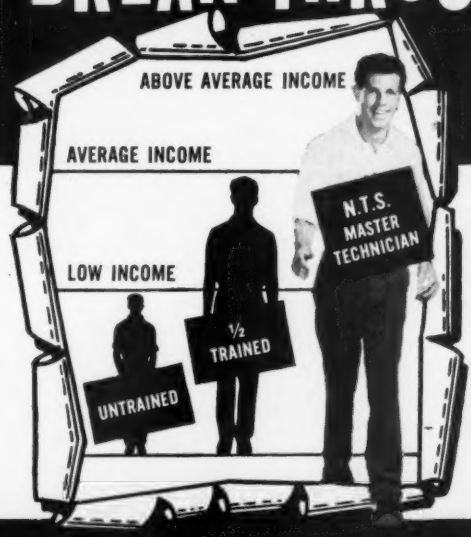

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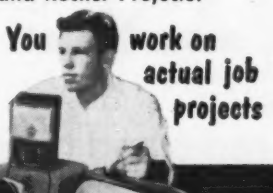

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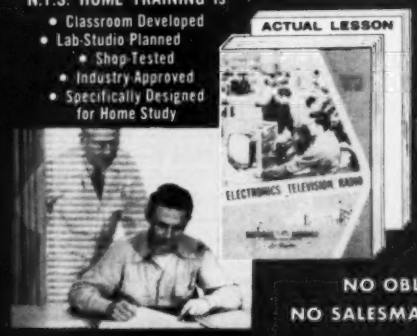

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out, there were several oversights in my article. First, the reader was not told the frequency meter crystal must be zero beat with WWV. Second, I assumed that the reader's BC-221 would be used with a regulated power supply. In addition, I mentioned the second harmonic of a 13.5-mc. *signal*. This is quite true, but I failed to point out that the signal was actually the fourth harmonic of the master oscillator.

However, the most serious error by far is the statement about the large graph! Obviously the dial can only be read to 350-400 cycles per tenth division. If the graph were ten feet high, it would be no more accurate. Somehow, when preparing the material, I came up with the figure 380 cycles per dial division rather than the actual figure of 3800 cycles.

I think you will agree the tolerance mentioned in the manual has no bearing on the discussion. The accuracy of the meter (up to the limiting factor of the dial reading) is entirely dependent on how well the BC-221 is calibrated, and the skill of the user. When properly calibrated the BC-221 is extremely accurate at the check points regardless of the frequency or harmonic being used. The error occurs between check points and in interpretation of the dial reading.

After receiving your letter, I measured the frequency of nine CB units with my BC-221. After each unit was checked, I again measured the transmitter frequency on my 75A4 communications receiver which *is* accurate to 100 cycles on all frequencies. In all cases I was 500 to 800 cycles on the high side, showing that my measurements were only accurate to .003 per-cent. I feel that this is satisfactory, but your method would exceed this.

Thus, to boil it down, a properly calibrated meter can be used to determine if the transceiver is within .005 per-cent in the hands of a skilled operator. Measuring the exact frequency is another matter, however.

DONALD L. STONER, 11W1507
Alta Loma, California

* * *

CAPACITANCE RELAY CIRCUIT

To the Editors:

In the circuit of the capacitance relay shown on page 86 of your October issue, there is an extraneous connection between the high side of T_1's primary and the cathode of the 2050 thyratron. This extra connection must be deleted, otherwise the circuit will blow some fuses.

AL WIECZOUK
Chicago, Illinois

In re-drawing Author Turner's original circuit we, unfortunately, threw in an extra lead which neither we nor the author caught in proofreading the article. Once this lead has been deleted, as suggested above, the circuit should operate properly as described.

Also, those of our readers who are having difficulty locating a 117N7 tube may substitute a selenium diode and almost any receiver beam-power tube with the heater rewired as required.—Editors. [30]

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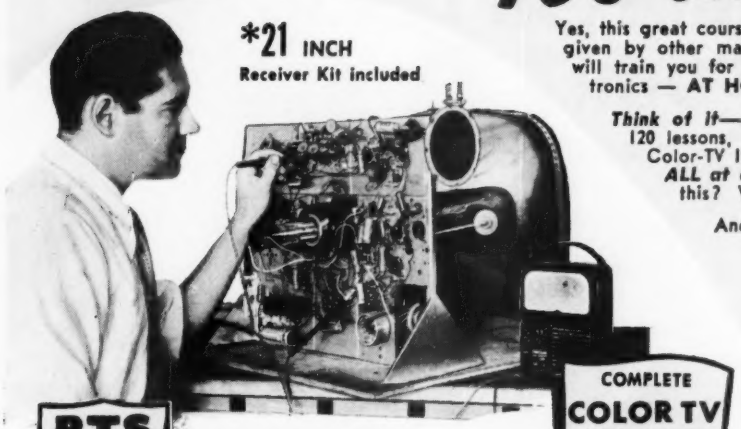

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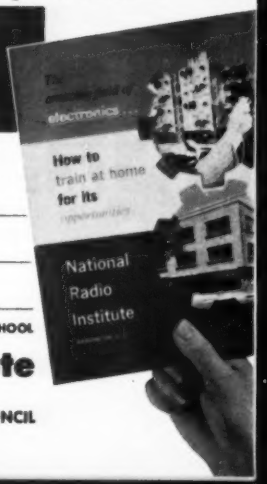

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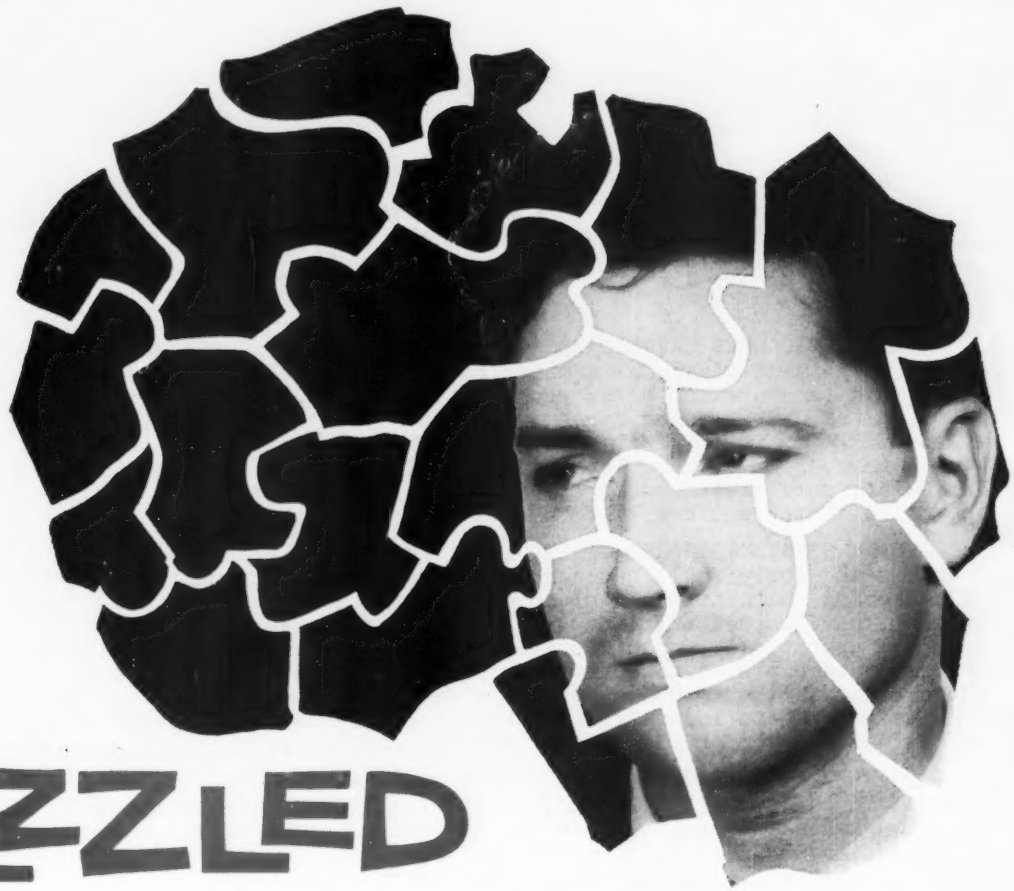

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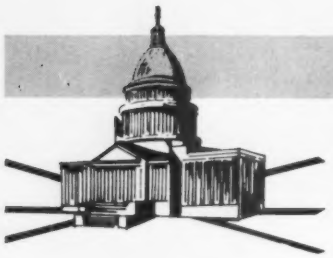

Latest Information on the Electronic Industry

Spot News

By ELECTRONICS WORLD'S WASHINGTON CORRESPONDENT

RADIO-WIRE COMMUNICATIONS NETWORK TO PROVIDE GLOBAL WEATHER SERVICE—The first phase of an improved global weather radio-wire teletypewriter communications network was placed in operation a few weeks ago. Announcing the project, F.W. Reichelderfer, chief of the U.S. Weather Bureau, said that when completed, the network will consist of an unbroken chain of point-to-point circuits encircling the Northern and Southern hemispheres. Four centers located in New York, Frankfort/Offenbach, Moscow, and New Delhi, were activated in the first phase of the program. Tokyo will be used for the fifth center which will be placed in operation during the spring of 1961.

TOLL-TV START POSTPONED—Trial subscription-TV, scheduled to begin in Hartford, Conn. in the early fall, has now been indefinitely postponed, pending the results of a hearing initiated by a group of local motion-picture owners. In calling the hearing the FCC said that they hope to find out..."whether the conduct of the proposed operation...would deprive viewers of...program services, which might otherwise be expected to be available under the established system of television broadcasting without the payment of a direct charge." Another major question the Commission expects industry to answer is..."whether the operation...would adversely affect competition in the television broadcasting industry."

HAMS ASKED TO VACATE 18 FREQUENCIES FOR ARMY EXERCISE—To support a large 30-day Army field exercise (South Wind), involving 100,000 troops in the Eglin, Florida area, 18 amateur frequencies in the 144-148 and 220-225 mc. bands were recently set aside for communications purposes, and all amateurs within interference range were asked to remain off the air during this period. In requesting hams to cooperate, the Army said that because of the locations involved and directional antennas employed, interference-free conditions would obtain. Cooperation, it was said, would certainly enhance the excellent reputation which all radio hams have established over the years.

RADIO-GUIDE SYSTEM DEVISED—A taped radio-guide system which will provide each Chicago Natural History Museum visitor with a personal and portable tour has been developed. The system features a continuous tape player, transmitter, and closed loop antenna working on one of several frequencies to prevent crosstalk. In operation, signals are transmitted to a transistorized receiver weighing less than one pound and equipped with an earphone and carrying strap.

100-TON RADAR ANTENNA INSTALLED—A three-section experimental radar antenna, weighing 100 tons, was raised into position recently at the Federal Aviation Agency's National Aviation Facilities Experimental Center in Atlantic City, N.J. to make possible an early start on a research project providing altitude information through radar for air-traffic control. Construction engineers took four and one-half hours to hoist the antenna from a horizontal position and attach it to a 168-foot tower. The antenna, which was assembled in a special building near the supporting tower, was moved on maple blocks to a position at the bottom of the tower. Each section consists of 10 miles of precisely drawn and drilled aluminum waveguide, making for 1056 antenna elements.

COMMUNICATIONS SATELLITE PROGRAMS TRANSFERRED TO ARMY—Systems management of the $197-million "Courier" and "Advent" communication satellite projects has been transferred from the Advanced Research Projects Agency to the Department of the Army. "Courier," an experimental research and development vehicle weighing 500 pounds, has been designed to serve as a delayed repeater satellite at a 650-mile altitude, near-equatorial orbit. As a delayed repeater, which stores information until commanded to transmit rather than relaying it directly, "Courier" can provide a trunking capability for store-and-forward messages in an eventual world-wide network of orbiting satellites. "Project Advent's" objective will be to conduct research and development necessary to demonstrate the feasibility of a microwave communications satellite operating in a 24-hour equatorial synchronous orbit. Weighing a half a ton, the satellite will operate at a height of 22,300 statute miles and will be operated with two ground stations, one on each coast: in the vicinity of Camp Roberts, California and the other near Fort Dix, New Jersey. [30]

What Does F.C.C. Mean To You?

What is the F. C. C.?

F. C. C. stands for Federal Communications Commission. This is an agency of the Federal Government, created by Congress to regulate all wire and radio communication and radio and television broadcasting in the United States.

What is an F. C. C. Operator License?

The F. C. C. requires that only qualified persons be allowed to install, maintain, and operate electronic communications equipment, including radio and television broadcast transmitters. To determine who is qualified to take on such responsibility, the F. C. C. gives technical examinations. Operator licenses are awarded to those who pass these examinations. There are different types and classes of operator licenses, based on the type and difficulty of the examination passed.

What are the Different Types of Operator Licenses?

The F. C. C. grants three different types (or groups) of operator licenses – commercial radiotelePHONE, commercial radioteleGRAPH, and amateur.

COMMERCIAL RADIOTELE*PHONE* operator licenses are those required of technicians and engineers responsible for the proper operation of electronic equipment involved in the transmission of voice, music, or pictures. For example, a person who installs or maintains two-way mobile radio systems or radio and television broadcast equipment must hold a radiotelePHONE license. (A knowledge of Morse code is NOT required to obtain such a license.)

COMMERCIAL RADIOTELE*GRAPH* operator licenses are those required of the operators and maintenance men working with communications equipment which involves the use of Morse code. For example, a radio operator on board a merchant ship must hold a radioteleGRAPH license. (The ability to send and receive Morse is required to obtain such a license.)

AMATEUR operator licenses are those required of radio "hams" – people who are radio hobbyists and experimenters. (A knowledge of Morse code is necessary to be a "ham".)

What are the Different Classes of RadiotelePHONE licenses?

Each type (or group) of license is divided into different *classes*. There are *three* classes of radiotelephone licenses, as follows:

(1) Third Class Radiotelephone License. No previous license or on-the-job experience is required to qualify for the examination for this license. The examination consists of F. C. C. Elements I and II covering radio laws, F. C. C. regulations, and basic operating practices.

(2) Second Class Radiotelephone License. No on-the-job experience is required for this examination. However, the applicant must have already passed examination Elements I and II. The *second class* radiotelephone examination consists of F. C. C. Element III. It is mostly technical and covers basic radiotelephone theory (including electrical calculations), vacuum tubes, transistors, amplifiers, oscillators, power supplies, amplitude modulation, frequency modulation, measuring instruments, transmitters, receivers, antennas and transmission lines, etc.

(3) First Class Radiotelephone License. No on-the-job experience is required to qualify for this examination. However, the applicant must have already passed examination Elements I, II, and III. (If the applicant wishes, he may take all four elements at the same sitting, but this is not the general practice.) The *first class* radiotelephone examination consists of F. C. C. Element IV. It is mostly technical covering advanced radiotelephone theory and basic television theory. This examination covers generally the same subject matter as the second class examination, but the questions are more difficult and involve more mathematics.

Which License Qualifies for Which Jobs?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain, and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radiotelephone license qualifies you to install, maintain, and operate every type of radiotelephone equipment (except amateur, of course) including all radio and television stations in the United States, and in its Territories and Possessions. This is the highest class of radiotelephone license available.

How Long Does it Take to Prepare for F. C. C. Exams?

The time required to prepare for FCC examinations naturally varies with the individual, depending on his background and aptitude. Grantham training prepares the student to pass FCC exams in a minimum of time.

In the Grantham *correspondence course*, the average beginner should prepare for his *second class* radiotelephone license after from 200 to 250 hours of study. This same student should then prepare for his *first class* license in approximately 75 additional hours of study.

In the Grantham *resident course*, the time normally required to complete the course and get your license is as follows:

In the DAY course (5 days a week) you should get your *second class* license at the end of the first 9 weeks of classes, and your *first class* license at the end of 3 additional weeks of classes. This makes a total of 12 weeks (just a little less than 3 months) required to cover the whole course, from "scratch" through *first class*.

In the EVENING course (3 nights a week) you should get your *second class* license at the end of the 15th week of classes and your *first class* license at the end of 5 additional weeks of classes. This makes a total of less than 5 months required to cover the whole course, from "scratch" through *first class*, in the evening course.

The Grantham course is designed specifically to prepare you to pass FCC examinations. All the instruction is presented with the FCC examinations in mind. In every lesson test and preexamination you are given constant practice in answering FCC-type questions, presented in the same manner as the questions you will have to answer on your FCC examinations.

Why Choose Grantham Training?

The Grantham Communications Electronics Course is planned primarily to lead to an F.C.C. license, but it does this by TEACHING electronics. This course can prepare you *quickly* to pass F. C. C. examinations because it presents the necessary principles of electronics in a simple "easy to grasp" manner. Each new idea is tied in with familiar ideas. Each new principle is presented first in simple, everyday language. Then after you understand the "what and why" of a certain principle, you are taught the technical language associated with that principle. You learn more electronics in less time, because we make the subject easy and interesting.

Is the Grantham Course a "Memory Course"?

No doubt you've heard rumors about "memory courses" or "cram courses" offering "all the exact FCC questions". Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this "meaningless" material than to learn to understand the subject. Choose the school that teaches you to thoroughly understand – choose Grantham School of Electronics.

Is the Grantham Course Merely a "Coaching Service"?

Some schools and individuals offer a "coaching service" in FCC license preparation. The weakness of the "coaching service" method is that it presumes the student already has a knowledge of technical radio and approaches the subject on a "question and answer" basis. On the other hand, the Grantham course "begins at the beginning" and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC-type test so you can discover daily just which points you do not understand and clear them up as you go along.

HERE'S PROOF that Grantham Students prepare for F. C. C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Weeks
Neil W. Michel, 402 E. Jefferson, Owensville, Mo.	1st	12
L. Gordon Combs, RR#3, Box 279A, Hemet, Calif.	1st	11
Daniel A. Ruch, Station KVOZ, Box 1498, Laredo, Texas	1st	12
George H. Sanderson, 128½ W. 4th Street, Marysville, Ohio	1st	8
Donald F. Teneych, 58 Brighton Road, Worcester, N. Y.	1st	12
Richard Scherzer, Apt. 3, 1175 S. Franklin Ave., Los Angeles, Calif.	1st	13
Jerry Miller, P. O. Box 1253, Charleston, West Virginia	1st	11
David M. Tarter, 1174 Hilltop Road, Kansas City 4, Kansas	1st	12
Verne S. Melton, Jr., 1014 Canyon Road, Santa Fe, New Mexico	1st	8
Gerald T. Bullock, 613 Keefer Place, NW, Washington, D. C.	1st	12

Resident Classes Offered at Four Locations

To better serve our many students throughout the nation, Grantham School of Electronics maintains four separate schools – located in Hollywood, Seattle, Kansas City, and Washington, D.C. – all offering the same resident courses in F.C.C. license preparation. (Correspondence courses are conducted from Hollywood.)

For further details concerning F.C.C. licenses and our training, send for our FREE booklet, "Careers in Electronics". Clip the coupon below and mail it to the School nearest you.

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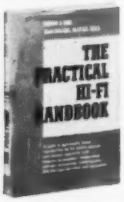

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The first non-technical book to provide useful information on the Revere Tape Recorder. Also a basic guide to the entire field of tape. Will show you new uses and add to your enjoyment. $1.95

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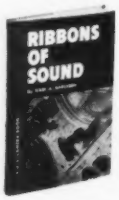

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Thoroughly covers the theory of magnetic recording, various types and makes of recorders, their applications and performance measurements. Includes chapter on important research problems. $6.25

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Within the Industry

DR. DONALD G. WILSON has been named vice-president for research at *P. R. Mallory & Co., Inc.*, Indianapolis.

In his new post, Dr. Wilson will supervise the company's electro-physical laboratories, its chemical laboratories, and the materials laboratories. Additionally, he will coordinate *Mallory* engineering and research activities throughout the country. He will expand the company's applied research program as well as establish additional research centers.

Before joining the firm, Dr. Wilson was an assistant vice-president and assistant director of research for *Stromberg-Carlson*. He was a consultant on the "Sidewinder" missile program at the U.S. Naval Ordnance Test Station and served on the staff at Rensselaer Polytech. He holds a Master's degree and Doctorate from Harvard.

* * *

HOWARD W. HIBSHMAN has been named sales manager of consumer products for *Stromberg-Carlson*. In his new position he will be responsible for the national marketing of stereo high-fidelity components and ensembles . . . **J. BRYAN STRALEY** has been elected president of *Reeves Instrument Corp.* Executive vice-president of the company since February 1959, he was also elected to the company's board of directors . . . **DAVID R. HULL** has been elected to the post of corporate executive vice-president of *Hoffman Electronics Corp.* . . . **G. G. ROBERTS** has been appointed technical director and a member of the board of *Cossor Radar & Electronics, Ltd.* of England . . . **JULIUS D. WINER** has been elected president of *Capehart Corp.*, succeeding his brother, **JACK M. WINER,** who died suddenly last August . . . **WILLIAM O. SPINK** has been appointed vice-president for sales of *Sylvania Electronic Tubes* . . . **KEITH A. SHARF** is the new production manager of *Marion Instrument Div.* of *Minneapolis-Honeywell*. He has been with the firm since 1949 . . . **L. HARRISS ROBINSON** has been named director of marketing for *Westrex Corp.*

* * *

W. MYRON OWEN, chairman of the EIA's Parts Division, has announced the establishment of a committee to study, analyze, and make recommendations on all aspects of the marketing of industrial electronic components.

According to Mr. Owen, president of *Aerovox Corp.*, the new Industrial Parts Marketing Committee is made up of executives who are concerned with the direct sales of components to original equipment manufacturers and industrial and military accounts.

Committee chairman is Wilfred L. Larson of *Switchcraft, Inc.* Other members are: Roland M. Bixler, *J-B-T Instruments, Inc.;* William H. Budd, *CTS Corp.;* Harold C. Buell, *P. R. Mallory & Co., Inc.;* George Butler, *International Resistance Co.;* Fran J. Chamberlain, *Clarostat Mfg. Co.;* H. A. Cornelius, *Littelfuse, Inc.;* Lew Howard, *Triad Transformer Corp.;* Matt Little, *Quam-Nichols Co.;* Frank L. Marshall, *Aerovox Corp.;* Robert T. McTigue, *Oak Mfg. Co.;* Walter E. Peek, *Centralab;* William H. Rous, *Amphenol-Borg Electronics;* Allen K. Shenk, *Erie Resistor Corp.;* Warren Stuart, *Belden Mfg. Co.;* and Norman Triplett, *Triplett Electrical Instrument Co.*

* * *

DONALD W. GUNN has been appointed regional vice-president of *Sylvania Electric Products Inc.*

In his new post, Mr. Gunn will have responsibility for the company's marketing activities in twelve Western states and Hawaii. A vice-president for sales of *Sylvania Electronic Tubes* since 1958, he will make his headquarters at the company's distribution center in Burlingame, Calif.

Prior to joining *Sylvania* in 1931, Mr. Gunn worked with *New England Power Co.* and *Raytheon.*

* * *

TELECTROSONIC CORP. has added 60,000 square feet to its operation in Long Island City, N.Y. The move involves a four-floor plant which will increase the firm's manufacturing facilities for tape recorders . . . **VEMALINE PRODUCTS CO.** has taken new quarters in Franklin Lakes, N.J. which provide three times the company's former working area . . . **RAI** (*Radiotelevisione Italiana*) has opened new offices at 717 Fifth Ave., N.Y. Mr. Giorgio Padovano, executive vice-president of the corporation, will head the new offices . . . **INDUSTRO TRANSISTOR CORP.** has announced construction of a new semiconductor applied research and development center in Natick, Mass. . . . **EITEL-McCULLOUGH, INC.** of San Carlos, Calif. has established a regional sales office in Belleville, N.J. . . . **HAMMARLUND MFG. CO.** has broken ground for a $350,000 addition to its plant in Mars Hill, N.C. . . . **NATIONAL ELECTRONICS, INC.** is adding 23,000 square feet to its Stevens Street plant in Geneva, Ill. . . . **CORNING ELECTRONIC**

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630 - 113	15 meters (Amateur) 21 - 21.6 MC
630 - 114	20 meters (Amateur) 14 - 14.4 MC
	15 MC (WWV)
630 - 115	40 meters (Amateur) 7 - 7.4 MC
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630 - 119	Special Frequencies 2 MC - 50 MC

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COMPONENTS has announced plans to build a new plant in Raleigh, N.C. for production of glass capacitors.

* * *

JAMES W. NOLAND has been appointed general manager of the *Gonset Division* of *Young Spring and Wire Corp.*, Burbank, California.

He formerly was manager of manufacturing for the West Coast producer of radio communications equipment. Mr. Noland's experience encompasses a 20-year period, including responsible positions in management, engineering, and production.

Prior to joining *Gonset*, he served as factory manager for *Globe Electronics*, Division of *Textron, Inc.*

* * *

WILLIAM O. SWINYARD, vice-president and director of *Hazeltine Research, Inc.*, recently celebrated his 30th anniversary with the company and was presented with a diamond pin. He is a former director of the IRE . . . **JOHN A. WITHERELL** has been appointed merchandising manager of *Pentron Sales Co., Inc.* In his new post he will be responsible for all advertising, sales promotion, product information, and publicity for the firm . . . **ROY HUNT** has been named national sales manager of the electronic organ and small instruments division of *Estey Electronics Corp.* . . . **CHARLES LAINE** has been named sales manager of the semiconductor division of *Semi-Elements, Inc.* He will continue to serve as assistant secretary of the corporation . . . **HENRY M. RUPPEL** has been elected vice-president in charge of production engineering for *Allied Control Co., Inc.* He joined the organization in 1944 . . . **ROBERT W. PIKE** has been named chief engineer in charge of research and development for *Industro Transistor Corp.* He will head the company's new semiconductor R & D center in Natick, Mass. . . . **RICHARD A. STONESIFER** has been appointed product sales manager for special tube operations of *Sylvania.*

* * *

DALE ELECTRONICS, INC. of Columbus, Neb., has been merged with **HATHAWAY INSTRUMENTS, INC.** of Denver, Colorado . . . The boards of directors of **JERROLD ELECTRONICS CORP.** and **HARMAN-KARDON, INC.** have approved the consolidation of the two firms. The two companies will continue to operate as heretofore, with no change in management, program, or location . . . **TENNY ENGINEERING, INC.** of Union, N.J. has contracted to purchase **COMMUNICATION MEASUREMENTS LABORATORY, INC.** of Plainfield, N.J. . . . **MODEL ENGINEERING AND MANUFACTURING CORP.** has acquired controlling interest in **MONTEK, INC.** of Salt Lake City. . . . Stockholders of **GENERAL INSTRUMENT CORP.** and **GENERAL TRANSISTOR CORP.** have approved a merger, with **GENERAL INSTRUMENT** the surviving corporation . . . **ASTROMETRICS, INC.** of Santa Barbara, Calif. has been incorporated.

[30]

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HF85 Stereo Preamplifier: Complete master stereo preamplifier-control unit, self-powered. Distortion borders on **unmeasurable.** Level, bass & treble controls independent for each channe or ganged for both channels. Inputs for phono, tape head, mike, AM, FM, & FM-multiplex. One each auxiliary A & B input in each channel. **"Extreme flexibility . . . a bargain."** — HI-FI REVIEW. **Kit $39.95. Wired $64.95.** Incl. cover.

New HF89 100-Watt Stereo Power Amplifier: Dual 50W highest quality power amplifiers, 200W peak power output. Uses superlative grain-oriented steel output transformers for undistorted response across the entire audio range **at full power,** assuring utmost clarity on full orchestra & organ. 60 db channel separation. IM distortion 0.5% at 100W; harmonic distortion less than 1% from 20-20,000 cps within 1 db of 100W. **Kit $99.50. Wired $139.50.**

HF87 70-Watt Stereo Power Amplifier. Dual 35W power amplifiers identical circuit-wise to the superb HF89, differing **only** in rating of the output transformers. IM distortion 1% at 70W; harmonic distortion less than 1% from 20-20,000 cps within 1 db of 70W. **Kit $74.95. Wired $114.95.**

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FM/AM Tuner HFT92 combines renowned EICO HFT90 FM Tuner with excellent AM tuning facilities. **Kit $59.95. Wired $94.95.** Incl. cover & F.E.T.

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HFS3 3-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, full-inch excursion 12" woofer (22 cps res.) 8" mid-range speaker with high internal damping cone for smooth response, 3½" cone tweeter. 2¼ cu. ft. ducted-port enclosure. System Q of ½ for smoothest frequency & best transient response. 32-14,000 cps clean, useful response. 16 ohms impedance. HWD: 26⅜" x 13⅞" x 14⅝". Unfinished birch. **Kit $72.50. Wired $84.50.** Walnut or mahogany. **Kit $87.50. Wired $99.50.**

HFS5 2-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, ⅝" excursion, 8" woofer (45 cps. res.), & 3½" cone tweeter. 1¼" cu. ft. ducted-port enclosure. System Q of ½ for smoothest freq. & best transient resp. 45-14,000 cps clean, useful resp. 16 ohms. HWD: 24" x 12½" x 10½". Unfinished birch. **Kit $47.50. Wired $56.50.** Walnut or mahogany. **Kit $59.50. Wired $69.50.**

HFS1 Bookshelf Speaker System complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps range. 8 ohms. HWD: 23" x 11" x 9". **Kit $39.95. Wired $47.95**

HFS2 Omni-Directional Speaker System (not illus.) HWD: 36" x 15¼" x 11½". **"Fine for stereo"** — MODERN HI-FI. Completely factory-built. Mahogany or walnut **$139.95.** Blond **$144.95.**

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††Shown in optional Furniture Wood Cabinet **WE70:** Unfinished Birch, **$8.95;** Walnut or Mahogany, **$12.50.**

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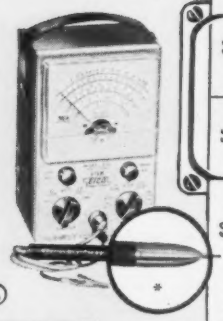

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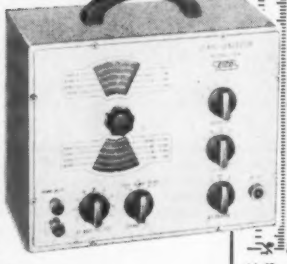

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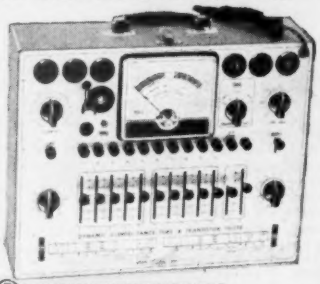

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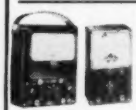

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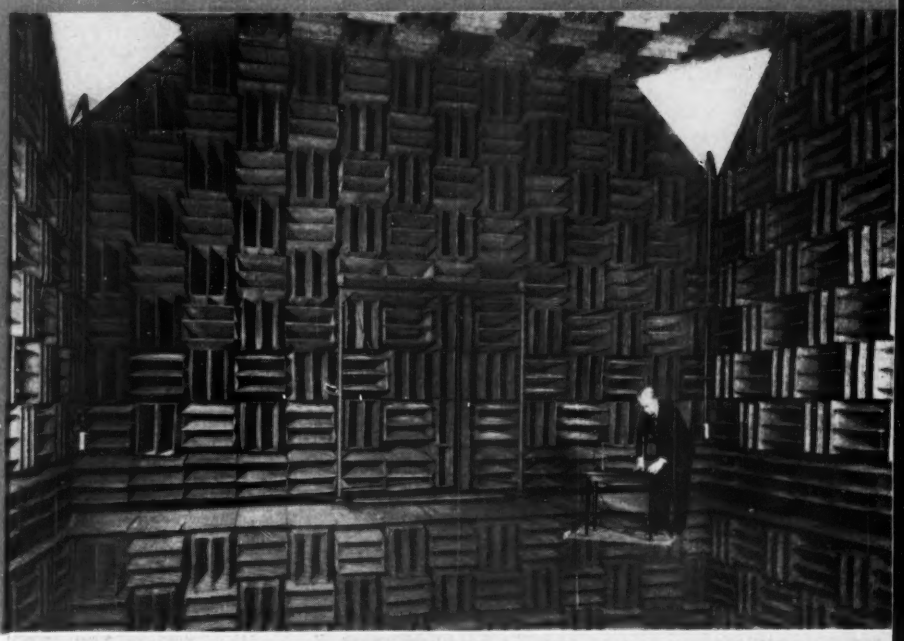


Bell Laboratories' free-space room is built in a 38 x 38 x 45 foot enclosure.

Rooms without echoes are employed to test speakers, microphones, plus other audio devices. Here is what goes into the design and building of such soundproof rooms or anechoic chambers.

Their Design & Use

THE study of sound generation and noise has become extremely important in recent years. The increasing sound consciousness of the general public is evidenced by the popularity of mono and stereo high-fidelity reproduction. Manufacturers of various types of equipment, not necessarily electronic, have been forced to study the noise problem from the standpoint of quiet operation. Sound-generating equipment manufacturers are being similarly forced toward more accurate evaluation of their products due to the increasing demand for outstanding performance.

In order to make a thorough sound analysis of a product, various sound-level measurements must be made with special equipment to determine directivity patterns, local sources of sound, acoustic efficiency, power output, and other important parameters. Each of these tests helps to improve the operation of a sound generator or silence a noisy unit.

If one were attempting to measure the light output of a flashlight, for example, one would intuitively select a dark room in which to run the test. Similarly, one of the basic necessities for making any meaningful sound-level measurement is an environment where the surrounding or ambient noise level is much lower than the sound level being measured. The measuring apparatus is incapable of filtering out the desired sound exclusively but must measure the total sound level that is incident on its microphone. If the surrounding noise is enough lower (approximately 10 db or more) than the sound from the product being evaluated, its contribution to the measured noise level can be considered negligible. In this case, it is safe to assume that the measured values are the sound levels being generated by the product.

Another important consideration is the sound reflectivity of the surrounding area. Returning to the flashlight analogy, one would also choose not only a dark room but one in which the surrounding surfaces reflected a minimum of light. It is important, therefore, that the reflection of sound be below a specific value for accurate measurements otherwise erroneous readings, which can be both costly and misleading, will result.

The best place for making such sound measurements is somewhere out in free space where the weather, and especially wind conditions, stays relatively constant. Unfortunately, no such practical place exists and the normal changing weather conditions we encounter would result in misleading sound measurements.

One practical solution to the problem of making sound measurements is to

Fig. 1. Wall-mounted fiberglass wedges are commonly used for soundproofing in a good many anechoic chambers and rooms.

construct a room in which the interior surfaces absorb all or most of the sound that impinges upon them. The other requirement for such a room is that it exclude most of the ambient or surrounding noise. Thus, the interior will not only be sufficiently quiet but any sound generated inside will radiate from the source just as it would in free space with no interfering reflections.

A room in which the walls have the property of absorbing over 99 per-cent of the incident sound energy is called an "anechoic" room. As the name implies, such a room is free from echoes. An anechoic room is a useful tool for both research and product development in such fields as: the automotive industry (muffler development and component testing); aircraft industry (noise produced by air moving equipment and component testing); electrical industry (transformers, motors, fluorescent lamps); appliance field (air conditioners, washing machines, fans, blowers, compressors, and refrigerators); business machines (typewriters and adding machines); medical (hearing examinations and heart research); radio-TV-audio equipment (loudspeaker, microphone, and musical instrument testing); as well as the testing of any equipment where accurate free-field sound level measurements are required.

There are, of course, some problems associated with the design of an anechoic room. The first of these involves the construction of sound-absorbing wall surfaces.

Wall Surfaces

In order to achieve these, many wall treatments have been designed, the most conventional being a wedge design. A single wedge has a triangular shape and is mounted on the wall in the manner shown in Fig. 1. The material used for such wedges is usually some form of mineral wool or fiber glass, both of which have good sound-absorbing properties.

Very often it proves unnecessary to make sound-level measurements over the entire audio spectrum (20 to 20,000 cps). For most applications, in fact, this is the case. The lower the frequency to be covered, the deeper the wedge required to absorb the sound. For this reason, a considerable saving in initial cost can be realized by careful pre-selection of the lowest frequency to be measured. The determining factors involved in this choice relate to the product itself. The lowest frequency point at which the wedges in the room have a sound absorption of 99 per-cent is called the "cut-off frequency." Note that this is the frequency below which the room stops being anechoic and wall reflections are set up, making measurements unreliable.

Recently a set of empirical equations has been developed for designing wedges for a particular cut-off frequency. However, an easier approach is to use a graph, such as that shown in Fig. 2, and make the depth (D) as required to obtain the desired cut-off frequency. The particular design shown does not necessarily represent the most economical configuration from the point of view of cost. It is only after a thorough study is made of the production techniques and the availability of equipment that the "most economical" configuration can be determined. The actual design of a wedge, taking all parameters into account, is rather complicated and the best solution is to resort to the equations or to utilize the standard wedge designs offered by various manufacturers. The latter method is preferable since such commercially available wedges have been tested and proved satisfactory.

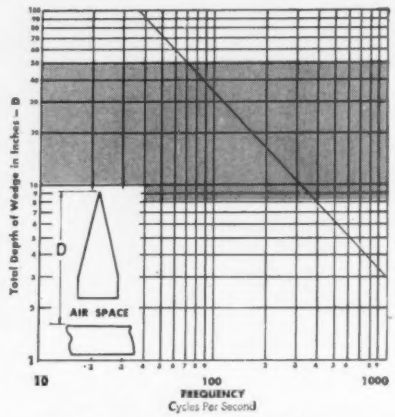


Fig. 2. Wedge depth vs cut-off frequency (based on "The Design and Construction of Anechoic Sound Chambers" by L. L. Beranek and H. P. Sleeper, Jr., JASA Vol. 18, #1).

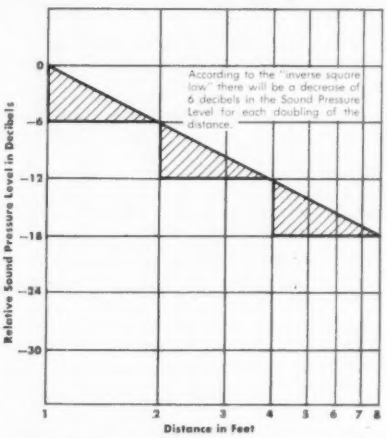
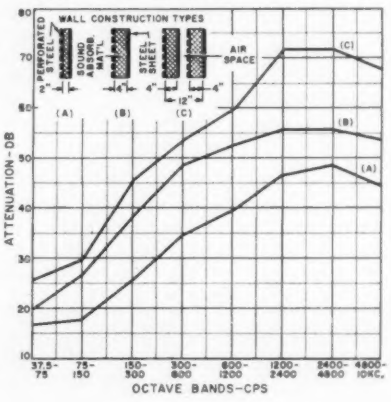


Fig. 3. Graph of the inverse square law.

Fig. 4. Attenuation for three different types of wall construction is shown here.



Attenuation and Cut-Off

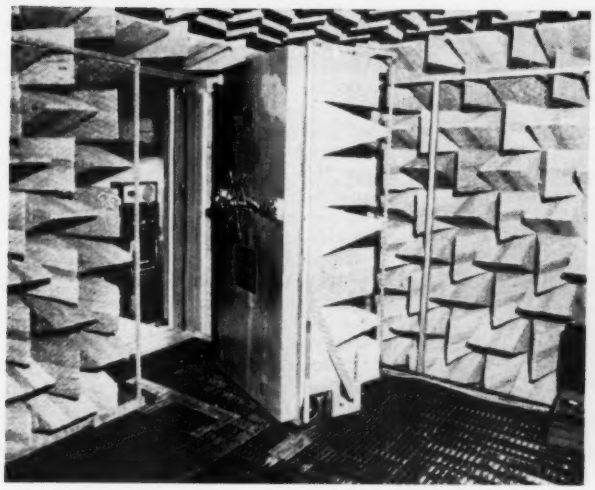
Once an anechoic room is installed there are two basic tests which should be run. The first of these involves the measurement of *sound attenuation* of the room. The sound attenuation is the difference in the sound levels outside and inside the room. This is generally measured in frequency bands of an octave so that the sound attenuation of the room, as a function of any frequency octave band, is known. By dividing the audio spectrum into octave bands, an adequate performance picture, which is valid for most purposes, can be obtained. Very often half- and third-octave bands are used for more thorough analysis. Pure-tone frequencies are rarely used for such sound-attenuation measurements since they introduce various problems into the measurement techniques. Conventionally, an electronic random-noise generator, which generates a noise containing all frequencies, is used. The measurement instruments then filter out the desired frequency band.

The primary purpose of the sound-attenuation test is to ascertain the maximum allowable ambient or surrounding-area noise level during the time tests are being conducted inside the room. If attenuation is inadequate, provisions must be made to improve the wall construction or to curtail some noisy operation outside the room during tests. Again, the wall structures supplied by manufacturers of acoustic products should be evaluated according to their attenuation characteristics, taking into consideration the chamber component construction as an important factor.

The second test which should be conducted is a determination of the cut-off frequency of the room to verify the predicted value and to determine the low-frequency limit for the room. One basic method is to locate a small sound source at one end of the room then measure the drop-off in sound level as the microphone is moved away from the source. This test is conducted with pure-tone frequencies.

In free space, the sound level drops off, theoretically, 6 db each time the distance from the source is doubled. For example, if a particular sound level is 100 db at a distance of 25 feet from a sound source, at 50 feet the level would be 6 db less, or 94 db. This drop-off in sound level is referred to as the "inverse square law." Fig. 3 shows the theoretical inverse square law curve starting with a measurement of one foot.

Since pure tones are used for the inverse square law tests in an anechoic room, source size, phasing, and microphone orientation all become critical factors in accuracy of the measurement. For most applications, a tolerance of ±1 db in measurement techniques is



View from interior of an anechoic room showing the use of soundproof door and grated floor. Note how heavy the door is built and the fiberglass wedges mounted on it. Large casters are used to support weight. The floor is almost acoustically transparent.

This young volunteer is having her speech recorded in an anechoic room for later analysis. By employing such a field-free environment, the speech is not masked or otherwise affected by extraneous echoes and reverberation. Playback speaker is in background.

acceptable. Therefore, the conditions of the inverse square law should be met within ±1 db for all frequencies down to the cut-off frequency. Below the cut-off frequency, it is possible to obtain inverse square law characteristics between the source and some location away from the wall. This location is dependent on frequency and the lower the frequency the farther away from the wall this point will be. One should investigate and take advantage of this extended range, if possible, when considering the construction of an anechoic room since it can result in a smaller chamber and, therefore, a dollar saving.

Fig. 4 shows the sound attenuation of typical installations, in octave bands, from the outside to the inside. It can be seen how the attenuation varies with frequency, being the lowest at the low end of the spectrum. It should be pointed out that attenuation is a function of the mass of the walls of the room. An increase in the weight usually increases the attenuation. With proper wall construction, however, maximum attenuation can be obtained for a given weight. Manufacturers of soundproof rooms offer various types of wall configurations which are designed to provide excellent attenuation with minimum weight. As a general rule, the more low-frequency attenuation desired, the heavier and more costly the room will be.

Panels and Construction

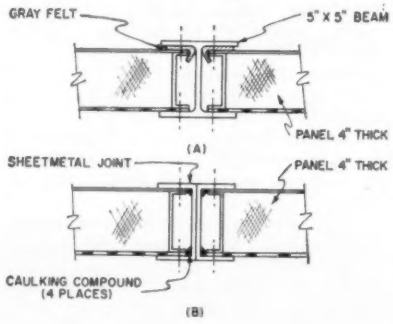
Insofar as the design of the acoustic panels themselves is concerned, this will depend on what the acoustic manufacturer has to offer. The basic construction for all good panels involves a sheetmetal outer face, an acoustical filler material, and an interior perforated face. The finer points of panel design will vary from manufacturer to manufacturer, depending on their own development studies, practical field experience, and manufacturing capabilities.

The familiar adage, "a chain is no stronger than its weakest link," certainly applies to the construction of an anechoic room and its associated components. As mentioned previously, with proper design it is possible to obtain maximum acoustic attenuation for a given weight per square foot of treatment. Once this basic wall design is determined, however, precautions must be taken in order to preserve this attenuation when combining the panels to form a complete room. Practical field experience and laboratory testing loom large in the design and selection of these various components. Aside from the panels themselves, the basic components which go into the construction of the complete anechoic room are: panel joiners, floors, chamber vibration-isolation systems, doors, windows, and ventilation systems.

Some of the design considerations involved in these six chamber components will be considered, more as an indication of what is important than as a comprehensive discussion of specifications.

Panel Joiners: Once the design of the panel itself has been determined, the method for joining the panels to one another must be considered. This "joiner" must be acoustically compatible with the panel itself, that is, the joiner must be as good or better than the panel, otherwise sound would be transmitted into the room through these panel joiners. Depending on the thickness of the panel, various structural "I" beams or wide-flange beams are available which would lend themselves nicely to such an application. By using felt gaskets on each side of the beam flange, a tight fit between panel and joiner can be obtained. Bolting the entire assembly together adds to the acoustical "tightness" of the structure. Since wall panels are designed for a particular installation, there will be cases where panel thickness is such that no structural beam will be adaptable. In such cases, specially designed sheetmetal joiners, which are sized to accept the panels themselves, can be used. The two types of joiners are shown in Fig. 5.

Fig. 5. Methods of joining wall sections.



Note that due to the large clearances between the panel and the structural "I" beam, a felt seal is required, whereas caulking compound in each of the corners of the sheetmetal joiners is sufficient because of the closer tolerances in the sheetmetal joiner design.

Floor: In an anechoic room, there are two types of floors to be considered: one floor forms the remaining outer closure for the four walls and ceiling to make up the full room. In order to make the room completely anechoic, the floor itself must be made up of acoustic wedges. Above these wedges a second floor serves as the working area and allows equipment to be placed in various locations and personnel to maneuver about. The requirements for the outer floor are rather simple and two-fold. It must be acoustically compatible with the rest of the chamber and structurally able to bear any loads transmitted to it by the weight of the chamber itself and the equipment and personnel loading associated with the chamber.

The inner floor can be constructed of either grating or a spring-suspended cable system. Aside from structural considerations, the problem is complicated by the requirement that whatever material is used as the inner floor must have a minimum of reflective surfaces. The application of the room, together with field or laboratory data, is helpful

in determining which of the many grate or cable designs is best suited to the particular installation. Standard products are, of course, preferred and manufacturers of this type of material should be consulted for suggestions as to the best product for the application. Experience has shown that because of its simpler construction a grated floor is preferable and satisfactory from an acoustical point of view. In addition, a grated floor does not produce the "trampoline" effect that a cable system does, thereby allowing greater mobility on the part of the personnel.

Chamber Vibration-Isolation System: The most elaborate wall, ceiling, and floor construction can be made acoustically inadequate, especially at low frequencies, if close attention is not paid to the vibration-isolation system used with the room. Just as sound travels through the air, it can be transmitted through structural members and along the floors of a building. If the anechoic room is not adequately isolated, sound can be transmitted from the floor of the building, in through the floor of the chamber, and so into the interior of the

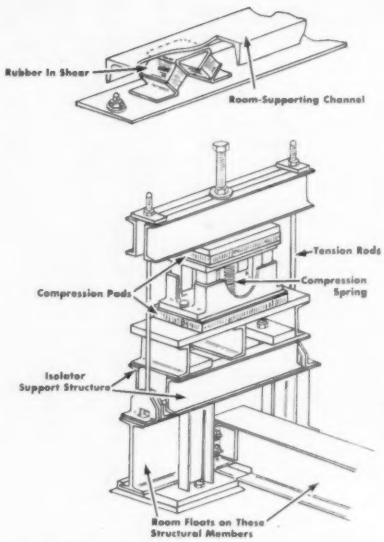


Fig. 6. (Top) A typical rubber-in-shear mount and (below) spring-suspension system. The latter is based on designs by Albert Kahn Associated Architects and Engineers.

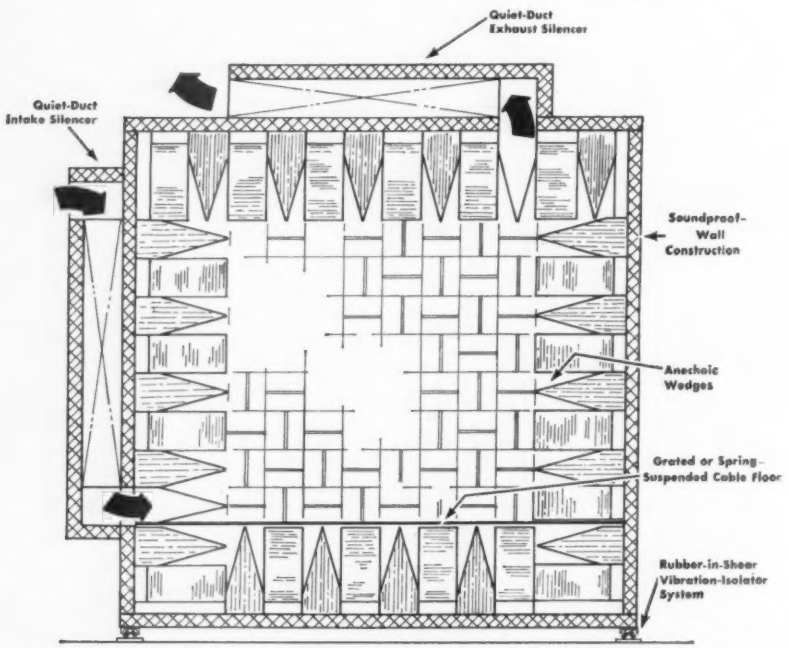


Fig. 7. Cross-section of typical anechoic room showing details of construction. Note how the air ducts are specially designed to quiet the sound due to air motion.

room. This, of course, defeats the original purpose of the anechoic room. Such vibration-isolation systems can range from simple rubber isolators to the complicated spring isolation systems shown in Fig. 6. The choice of a particular isolation system depends on the interrelation of the disturbing frequencies present in the area, the natural frequency of the contemplated vibration-isolation system, and the acoustic results desired in the chamber.

Doors: There are a number of door designs that lend themselves to use in anechoic rooms. The door leaf, door frame, hardware, and seals are the major components which require consideration. The door leaf is of the same basic construction as the wall panels in the chamber except that it must incorporate additional internal structural stiffeners. Since wedges are also mounted on the inner face of the door, these internal structural stiffeners must be so placed that the door will not be twisted and warped because of this additional weight.

The door frame is basically a component part of the wall itself, adequately re-inforced and designed to be the closure point for the seals on the door leaf. The hardware associated with soundproof doors, such as those used in anechoic rooms, are generally heavy-duty standard units which can support the weight. A positive pressure latch which upon closure holds the door leaf securely against the door frame, compressing the acoustic seals, is a definite requirement for this application. The hinges themselves must be of adequate size to carry the weight of the door leaf. Most door latches used with anechoic rooms utilize an inside release rod somewhat similar to those used on refrigerator doors. This allows the door to be operated both from the outside and inside of the chamber.

Assuming that the door leaf and door frame are acoustically compatible with the wall panels of the room, the next important feature involved in good acoustic design is the door seal. Such seals must allow the door to be closed without a great deal of effort while at the same time prevent any leak-through of sound. There are a number of products and designs on the market which are suitable for anechoic door seals. In general, adhesive-backed sponge rubber is used in a number of installations but sometimes more complicated pneumatically operated seals must be employed.

At the bottom of the door where the sill is located, specially designed drag seals, automatic drop seals, or similar units may be used. See Fig. 8 for details on a typical door design along with the photo on the previous page.

Windows and Window Plugs: In some anechoic room designs an observation window is required although the window affects the interior acoustical characteristics of the room. This effect is negligible if the total glass area is kept at an absolute minimum. Again, it is necessary to make the window as acoustically compatible with the panels of the room as possible. This is often done by using reasonably thick window glass and making a double window, *i.e.*, two window panels separated by an air space which equals the thickness of the panel.

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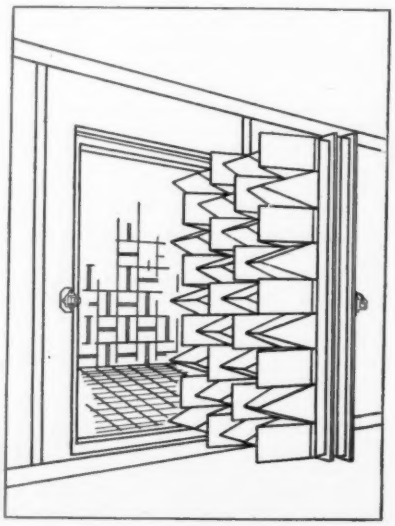
Fig. 8. Drawing showing anechoic door.



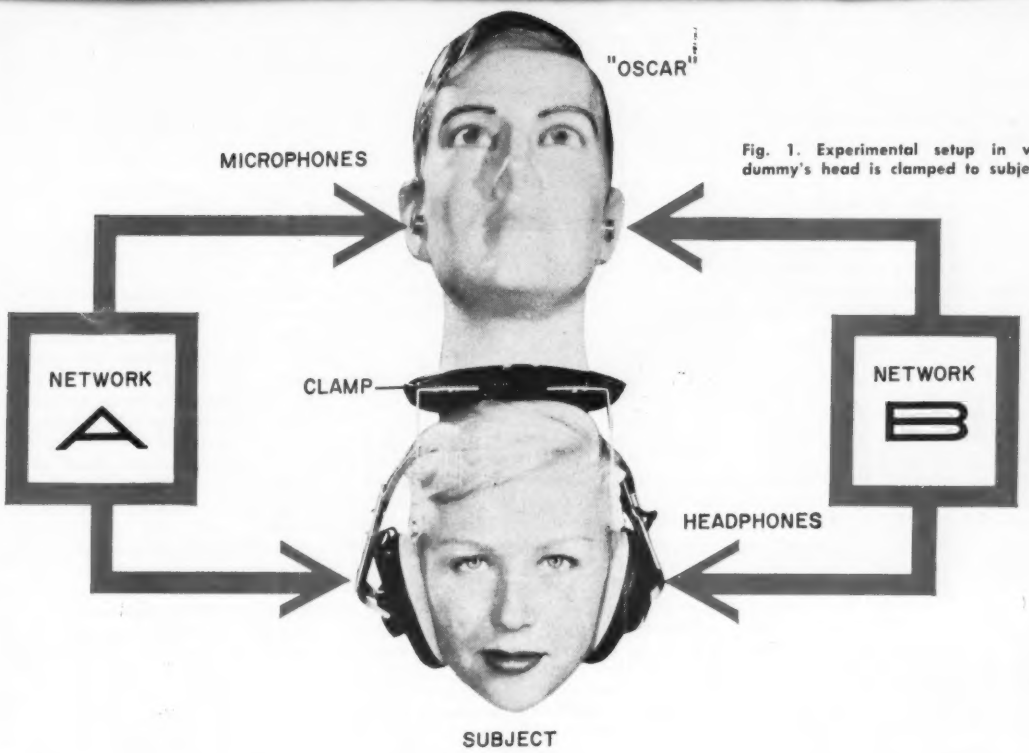


Fig. 1. Experimental setup in which the dummy's head is clamped to subject's head.

COVER STORY

SOUND DIRECTIVITY

how it is determined

By **R. L. HANSON**
Bell Telephone Laboratories, Inc.

Experiments with a dummy head in a "dead room" improve our understanding of sound and help develop better stereo.

RESEARCH in the field of sound can take on some rather peculiar twists, as witness this month's cover. The setup shown in the photograph was devised to explore the mechanism by which we determine the direction of sounds. Knowledge of this nature can be very useful in studying stereophonic sound systems, and in determining their effectiveness.

The dummy head (variously called "Oscar" and "Roland") serves a very special purpose in these experiments. A microphone is located in each of his ears. The microphone, in turn, is connected through a network to the corresponding headphone on the subject's ear. Fig. 1 shows details of this arrangement. Sounds picked up by "Oscar's" microphones can be amplified, shifted in phase, attenuated, or processed in any desired manner by the networks before being fed to the subject's earphones. This provides great flexibility in performing experiments.

Before using "Oscar," tests were conducted on various subjects to see how closely they could determine the direction of a sound. The tests were carried out in the "dead room," or anechoic chamber, with a setup somewhat similar to that shown in Fig. 2A.

Ten loudspeakers were arranged on an arc of a circle from straight ahead to 45 degrees to the right. The subject's head was clamped in place. One loudspeaker at a time was switched on and the subject was asked which speaker was in operation. For this test, the sound source was a sine wave with a frequency of a few hundred cycles per second. This sound source was applied to the speaker with a smooth rise and fall time of three seconds.

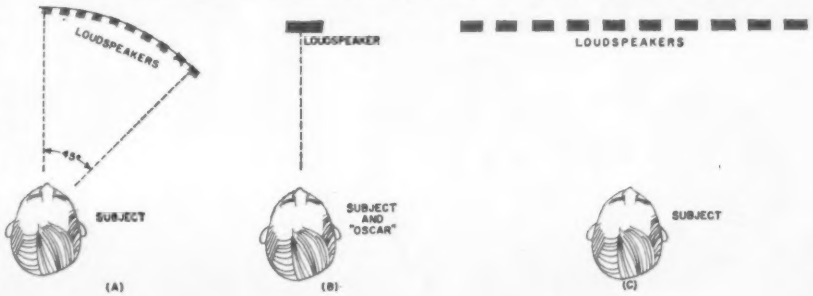
The subject had little or no difficulty in selecting the correct speaker for the sound source even though the speakers were quite close together and the subject's head was clamped firmly. He was seldom more than one speaker off, and usually selected the correct speaker.

Next, "Oscar" was introduced into the experiment as shown in Fig. 1. Networks A and B were carefully matched and adjusted in gain and phase so that the signal at the headphones matched that of the microphones. "Oscar" was clamped to the subject's head and moved with the subject. With this arrangement, the subject had little or no difficulty in accurately locating the operating speaker.

"Oscar" was then removed from the subject's head and clamped rigidly. The

(*Continued on page* 74)

Fig. 2. (A) Test setup in anechoic chamber for testing the accuracy with which a subject can locate a sound source. Ten speakers were used. (B) Arrangement for determining effects of variable amplitude and phase on subject's ability to sense direction. (C) Arrangement used in a live listening room (Arnold Auditorium) to show the difficulty of determining sine-wave source direction with reverberation.



Tips on Transistor Radio Service

Routine tests—if you know what they are—take the mystery and problems out of repairing these sets.

By **HERB BROWN**

Fig. 1. Close-packed wiring on typical circuit board highlights soldering hazard.

IF YOU ARE the average service technician, you have had your share of troubles in handling defective transistor radios. More than once, you have probably said to yourself, "Sure I can fix it—if I can find it." "Finding it" is usually complicated by the fact that the faults likely to occur in these radios are not necessarily the ones most likely to crop up in tube radios and the methods for finding them may also differ.

True, there are some electronic mysteries in transistor radios when they are compared rigidly to their tube-using counterparts, but you don't have to be a great theoretician to do the job. You can do a satisfactory job on almost all of the transistorized sets that come into your shop while staying pretty much on the practical side.

Since familiarity is your greatest weapon, accept all transistor jobs that come your way. But be prepared to trade some extra time for the kind of experience that pays the grocery bills in the long run. Don't jump to conclusions. On the other hand, it is fairly safe to assume that there is nothing occult about the defect, and that the trouble will prove to be rather simple once you have pinned it down.

One pitfall is that you may be prone to try first the things you should attempt last. When nothing obvious shows up, there is a tendency to experiment with the adjustments of i.f. transformers and tuning trimmers. Re-alignment is a little tricky. You are likely to get into serious trouble just by stripping the threads on a miniature coil through trial adjustments that were unnecessary in the first place. Look at the two miniature i.f. transformers in Fig. 2. They are both of the same type except that the one to the right has been removed from its tiny can to show some detail. Just a little extra pressure on an alignment tool could result in permanent damage.

Unless the slugs were loose or showed obvious signs of prior manipulation, why *should* they need re-adjustment? Yet we have seen transistor radios by the dozen whose repair was unsuccessfully attempted by other shops. With rare exception, a frantic try at repair had led to improper setting of every adjustable screw in the sets. And that's bad news.

To handle these sets properly, your principal equipment will consist of a milliammeter and a well-filtered, low-d.c. power source. The former is needed because most faults on the radios will show up most clearly as changes in current drain. The latter is useful to conserve batteries and also to highlight faults where the battery supply may be involved in some way. If you do not have this basic equipment on hand, you may be interested in a combination unit, like the *Sencore* PS103, which includes both the milliammeter and the power supply.

What you are going to look for depends on the symptoms. Accordingly, without analytical frills, we will cover the most usual symptoms encountered along with probable causes and the checks involved.

Dead or Intermittent Set

Are the batteries inserted in the correct polarity? The non-technical set owner is quite likely to insert one or more batteries the wrong way. Are the batteries themselves in good condition? Rather than checking them directly, try another power source to see how the set works. The batteries themselves may be good but the manner in which they are connected may result in poor or intermittent contact. To check the latter, apply power directly to the power leads.

If the set has a jack for a phonograph or an earphone, make sure that this unit is not improperly opening up the circuit when no connection is made to it. The "on-off" switch may not be working properly. The only way to check this is to determine whether the set draws current whenever the switch is turned on and draws none when the switch is turned off. Use your milliammeter.

If a dead or intermittent set has passed these tests, the speaker may be at fault. In a dead set, the speaker can be checked by trying a 1½-volt cell across the voice-coil leads to see whether a click is produced. If no click is heard, try another speaker.

If there is still no clue as to the fault, it probably lies in either of two remaining directions: either the output stages are involved or the local oscillator is malfunctioning. To check, set up the milliammeter to read total current drain, turn the set on with the volume control all the way up, and rotate the tuning knob across the entire band. If the oscillator and i.f. stages are working, the drain will vary as the radio is tuned through receivable stations of differing strength. For example, it might vary over the range from 5 to 25 ma. Should this check out, the difficulty is probably in the output stages.

If the current drain remains low and steady regardless of the dial setting, the oscillator should be checked for operation. This can be done with any standard broadcast receiver that happens to be handy, without an elaborate equipment set-up. Turn on the latter receiver and tune it to receive any station toward the upper end of the AM band. Now tune the transistor set so that its dial pointer is at a frequency equal to that of the station being received minus the i.f. of the transistor set. For example, if the operating standard receiver is on a station broadcasting at 1040 kc. and the i.f. of the transistor radio is 455 kc., the latter should be set so that its tuning dial indicates 585 kc.

Keep the transistor radio close to the antenna coil of the standard receiver and (assuming both are turned on, of course) rock the transistor set's dial back and forth around the point to which you have set it. Since its oscillator will be tuned near the broadcast frequency of the station being received on the standard set, you should be able to get heterodyne whistles through the speaker of the latter. No whistle indicates that the oscillator of the transistor set is not working. This test, of course, does not apply to transistor radios that do not use superheterodyne circuitry, like 2-transistor sets.

If you cannot get any signal through the defective radio but noise is clearly audible in the speaker, the antenna is a logical check-point. Trouble with the antenna connections is common in such cases. Other antenna problems are discussed later.

The tests described so far will serve to localize most troubles to one part of the circuit although they need not pinpoint the specific defect. As to the latter, a large percentage of them turn out to be nothing more than poor solder joints on the printed board. A small, thin screwdriver or a metal probe with a short tip should be used to probe such connections in the suspected circuit. Many "dead" sets are brought to life with nothing more than this technique. To repair these joints, use a low-wattage soldering iron. Simply sweating the solder already at the point of connection may be enough to complete the cure. Use new solder sparingly.

Do not go over suspected joints indiscriminately with a hot iron, as you may inadvertently overheat transistors or cause permanent shorts across closely packed printed wiring. These

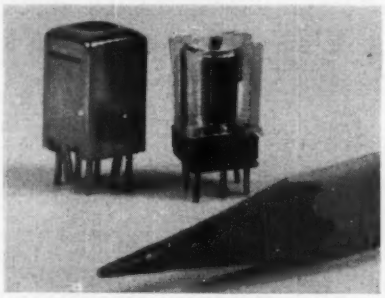


Fig. 2. Miniature i.f. transformers, one in can and one out (right), are delicate.

are not easy to find and correct later. The complete circuit board for one transistor model is shown in Fig. 1. It should make the reasons for the precautions stressed here quite clear.

When you think you have the set working, make a final check for intermittent operation. Try holding it in various positions while it is on. Tap all parts lightly.

Weak or Distorted Output

The most common cause for this complaint is that the batteries are weak enough to require replacement. A check with fresh batteries or a substitute supply provides a quick answer. If this is not the case, the speaker may be defective. However, it may not require replacement: it may have picked up iron filings that can be cleared away. Foreign, metallic particles can enter through the speaker grille on most of these radios. Remember that these handy, portable sets are used in a wide variety of locations where they are exposed to such a hazard. The owner may take his radio to work, where filings may be on his workbench.

Weak or distorted output may originate with the antenna. The antenna coil may easily shift to the wrong position on the ferrite rod. If so, the symptom may be especially noticeable on the lower part of the tuning range. Two views of the same antenna appear in Fig. 3. When it is not held in place, the coil can easily shift between the two extreme positions shown. After you have adjusted a loose coil to the optimum position, anchor it with cement or wax.

If the coil is fixed in optimum position, the ferrite rod may be broken inside the coil, where you cannot see it. To check for a break, hold the antenna rod at its ends and flex it gently.

If these tests prove negative, you may have an open i.f. stage. Check with your milliammeter. Total current drain will be less than normal with the volume turned up to maximum. If you don't have the manufacturer's figures on hand for comparison, check against a similar model that is functioning properly. With experience, you will get to know what to expect on drain readings.

Batteries Don't Last

When this complaint comes from the customer, it should not necessarily be taken at face value: he may simply expect too much. Your final authority is, once more, your milliammeter. The manufacturer's data or your own experience tells you how much current to expect the set will draw. As a rough figure, drain should vary from 5 to 25 ma., depending on signal strength and volume-control setting.

The way in which a normally operating set is used may shorten the expected life for the type of battery or batteries employed. This possibility should be discussed with the owner. Regularly high volume-control settings exhaust bat-

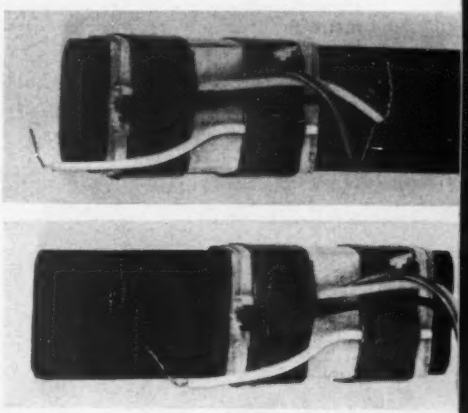


Fig. 3. A loose antenna coil may have shifted position along its ferrite rod.

teries rather quickly. If the set is kept on for long periods of continuous use (two or more hours), total battery life will be shorter than if it is used for more but shorter periods (perhaps one-half hour or less at a time). The use of earphones may have something to do with battery drain.

Many earphones draw less current than the speakers whose place they take. However, if the owner uses the ear-piece frequently, it pays to check current drain with the earphone he has. If it requires a higher volume-control setting in normal use than is needed with the speaker, or if the milliammeter shows it draws more heavily than the speaker, it may be possible to replace it with a more efficient device.

Defective switches are often responsible for short battery life. With the miniature types used as "on-off" controls, the switch may fail to open completely in the off position, permitting some leakage, even though a definite click is heard when it is turned off. This is not always easy to check with a milliammeter because the volume control is all the way down when the switch should be off, and this limits the current drawn; so don't expect the kind of current reading you would get with the set normally on. Fortunately, many of these miniature switches can be repaired simply by bending the contact points, which are accessible outside the switch housing.

Other possible causes of excessive current include leakage through a defective transistor or capacitor.

No method is fully automatic. However, these checks will seldom fail to bring you close to home. [30]

Jet Flight Trainer

A Navy pilot is shown here receiving final briefing from the instructor in the background prior to taking a simulated flight in the flight trainer developed to simulate an F-100A Super Sabre jet. The trainer employs a $2-million high-speed digital computer developed by *Sylvania* under a joint Navy-Air Force contract. During a simulated flight the instructor can introduce more than 50 emergency conditions similar to those experienced during actual jet travel. One or more problems such as flame-out, icing, landing-gear failure, or instrument failure, may be inserted at the same time.

Recent Developments in Electronics

"Scrambler" for Phones

The first portable transistorized "scrambler" device for use with business, industry, and law-enforcement agency telephones is being marketed by *Delcon Corp.*, Palo Alto, Calif. The 27-ounce unit is simply placed against the handset and the speaker's voice is scrambled into incoherent gibberish before being transmitted over the phone lines. A second similar unit, at the receiving phone is required to unscramble the conversation. The scrambler sells for just over $200.

Computers Learn English

A new programming system is being used with the *RCA* computer shown above. Known as COBOL (Common Business Oriented Language), the system substitutes simple English words for the complicated numerical jargon now employed in computer use—as witness the two equivalent sets of instructions on the blackboard. Basis for COBOL was worked out by a committee of manufacturers at Defense Department's behest to provide a single interchangeable language applicable to computers of different makes.

Plastic-Enclosed Relay Station

A 560-sq. ft. enclosure, made of transparent Plexiglas, has been installed recently by the *N. Y. Telephone Co.* at its microwave relay station on the 87th floor of the Empire State Building. This enclosure—high in the clouds over Manhattan—has enabled the station to increase the number of its microwave dishes from four to twelve on one side of the building. Photo shows antennas being installed.

Testing Transistors for Missiles ▶

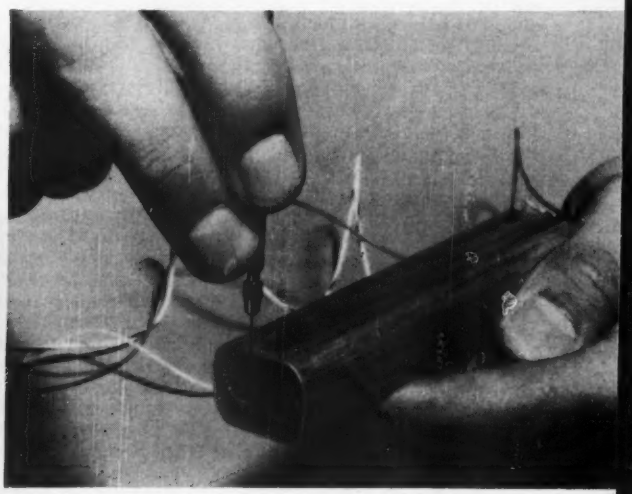
Power transistors heavily encrusted by salt are checked as part of the "Minuteman" missile reliability program being conducted by *Delco Radio*. The transistors will be cleaned and inspected visually for corrosion, erosion, rust formation, and then will be put through full electrical tests. Other environmental tests conducted on the power transistors in this program include humidity, fungus, radiation exposure, moisture, sunshine, sand, dust, shock, temperature cycling, and vibration test to insure power transistor reliability under all environmental conditions in which "Minuteman" missiles might be stored.

◀ New Army Sniperscope

Army sharpshooter sights through new infrared sniperscope which can spot the enemy from much farther away than its World War II predecessor. Developed by *Raytheon Co.* for the Army's Engineering Research & Development Laboratories, the new sight is scheduled shortly for large-scale production. Instead of cumbersome World War II back pack, the entire power supply is carried in lightweight cartridge belt container.

Radiation Detector for Space

Thin slice of silicon forms the tip of a new radiation detector developed by *Hughes Aircraft Co.* nuclear physicists for the Air Force to measure the amount of radiation man will meet in outer space. The USAF school of aviation medicine will launch the detectors in simulated spacecrew cabins of high-altitude balloons and on "Atlas" missile space flights. The device shown below will provide a count of radiation penetrating a spaceman's cabin and feed the information to a telemeter system for transmission to receiving stations on Earth. ▼



Light Image Intensifier Tube

A new high-vacuum tube, type WX-4047, which intensifies light radiation by electronic means is available from *Westinghouse*. The new tube produces an image of reduced size whose brightness is increased by a factor of 2500 for actinic blue input radiation. ▼

REPORT ON

N.Y. HI-FI SHOW

THE New York Hi-Fi Show, sponsored by the Institute of High Fidelity Manufacturers, Inc., was held this year very early in September and it is thus possible to bring you a report in this Christmas issue. Since you will have this issue in your hands well before Thanksgiving, it will give you plenty of time to do your Christmas hi-fi shopping.

I want to tell you about the many delectable new models of hi-fi gear dreamed up by the manufacturers. Actually, the term "new" needs a little explanation. There were some *totally* new items, of course, but much of what was shown was not new in the sense of a true innovation, but rather newly revised or refined.

There was none of the hectic, fevered running from room to room, with new marvels disclosed everywhere, as was common in years past. The "hi-fi bug" was really a bug in those days . . . a madly enthusiastic individual, with a fanatic zeal for experiment . . . the kind of a guy who would hock his false teeth and sell his grandmother for another 5 cycles lower response from a speaker. These individuals have been much maligned, but it is they who were responsible for the mushroom growth of hi-fi and the burgeoning of a whole new industry.

These boys are still around and still carrying the torch . . . only it doesn't burn quite as brightly as in the old days. You can see them in the various rooms, discussing equipment with quiet authority, still looking for that hi-fi grail. Yes, the pattern has changed and many an old timer rather nostalgically mourns their passing.

Today, the atmosphere is more "strictly business" and everything is run very efficiently . . . why many of the exhibitors don't even make noise any more! This, too, is an index of the trend in the hi-fi market . . . in the old days, they played *real* music, great classics which had received the benefit of some advance in recording techniques and which the exhibitors seized upon and played loud and lustily to show off their equipment. Some of today's exhibitors use corny junk, phony music all hypoed and doctored up with trick recording gimmicks to try and make some of their equipment sound good. To this end they succeeded quite well, if your main interest in music is middle frequencies and little else!

A number of speaker manufacturers I talked with said that they felt that the small speaker craze had reached its crest and that there were indications that the larger speakers were due for a comeback. They honestly admitted that the small speaker would continue to ring up the largest sales, but that they expected to augment this income with revenue from the bigger and the more expensive units.

Attendance at the Show was very good and it was generally felt that this Winter and Spring would produce increased sales. There is the belief that the consumer market has straightened itself out and that the chaos that was due to all the confusion about stereo is over. They feel that stereo has now become a stabilized factor and that it will continue to expand and make further inroads on mono. The latest figures from the Record Industry Association would seem to support this contention. For example, in 1958, classical music hit its lowest point in some years, accounting for only 11 per-cent of the total record market. In 1959, the classical record market reached the eye-opening figure of 25 per-cent, with stereo accounting for better than 50 percent of these sales. So far in 1960, the upward trend continues with stereo growing ever greater in percentage. So while there are dark and dangerous spots in the industry, in general the attitude at the Show was healthy optimism.

Since I covered tape developments in my column "Sound on Tape" in this issue, I will confine myself here to other items of interest at the Show.

Walking into the room of *Audio Empire* disclosed the startling sight of a turntable, arm, and record suspended upside down and playing merrily away! This newcomer to hi-fi manufactures a very clean and functional looking turntable and arm which, from its upside down performance, is obviously precisely balanced statically and dynamically. *Acoustic Research* was showing its well-known speakers, including the new AR3 which incorporates a new type of tweeter with response claimed beyond 20,000 cycles. *Advanced Acoustics* was showing its all-wood coneless speakers without frames for in-the-wall between-the-studs mounting and some of its other speakers actually had oil paintings on their front faces. Genial Rudy *Bozak* presided over his line of speakers and pridefully showed me several new models in traditional and modern stylings designed to break down the resistance of the ladies. And, for the man who wears the pants in his family, he is still showing his monolithic five-foot-high Model 310, which with 48 inches of woofer area and 16 cubic feet, really pushes out the bass.

British Industries had swarms of people around a completely new *Garrard* unit which doubles in brass as a changer and a turntable and for which a very low rumble figure is claimed. The little *Wharfedale* speakers with sand-filled panels evoked a lot of comment about the lack of resonance and the cleanness of their bass while the bigger *Wharfedales* were performing with their accustomed smoothness.

By **BERT WHYTE**

Here are some of the things we saw and heard. Most exhibitors were optimistic about their future market.

The *Conrac* people were showing their "Fleetwood" TV chassis with the "lazy man" wireless remote tuning. This company makes a good deal of the monitor equipment used in TV studios but oddly enough has not shown a color set for the consumer market nor do they plan to as yet. Of course, if you have roughly $4000, you can always buy one of their studio color monitors!

My friend Murray *Crosby* was showing some of his new multiplex adapters and demonstrating multiplex stereo on a closed circuit as well as showing his new tuner/amplifier and similar equipment from his *Madison Fielding* subsidiary. The stereo amplifiers, by the way, have a nifty "null" balancing device which puts you in balance when *no sound* is heard!

Incidentally, after years of kicking around by the FCC, it appears that a decision on multiplex will soon be forthcoming and we may have stereo broadcasts by Spring.

Dynaco's room was crowded with hip hobbyists who were looking at various amplifier and preamp kits they might be able to tackle and much favorable comment was heard about the Danish stereo pickup which *Dynaco* imports. Much the same could be said of the *Acro, Fico, Heath, Lafayette,* and *Paco* exhibits where the kit-conscious were gathered, including those who were interested in the new products on display.

ElectroSonic was demonstrating its latest d'Arsonval type stereo cartridge as well as its *ESL* gyro arm—another unit capable of playing upside down. *Electro-Voice* was showing everything from a tiny stereo cartridge to a build-it-yourself electronic organ. The huge horn-loaded "Patrician" speaker was pushing out some thunderously low bass *via* a new 30" woofer . . . that's right, friends . . . 30 inches! They claim that the use of new cone material has so reduced the mass that the old bugaboo of ultra-large-diameter woofers (slow start and slow recovery) has been overcome.

Ercona Corp. was showing a diverse line of hi-fi equipment with interest centered on a new model of the British-built "Connoisseur" turntable, claimed to be very low in rumble. *Fairchild* had a new belt-drive turntable at much lower price than previous units of this type but, despite the price reduction, superior in performance. Avery *Fisher* and company was out in full force with a big, impressive line of preamps, amplifiers, tuners, and a reverb unit for those who want to be brave experimenters. He was also showing his line of "packaged" units which were handsomely styled and impressive sounding too.

For those looking for record changers, *Glaser-Steers* and *United Audio* were showing off their wares while *Rek-O-Kut*'s display of tone arms and turntables was interesting. Joe *Grado* was demonstrating his new tone arm which incorporates lateral and vertical adjustments for optimum stereo tracking and his new stereo cartridge which, to these ears, was impressively smooth. The item of most interest, however, and on which Joe would not announce a release date was a turntable of new design, mounted in a big, thick slab of polished marble—a design I have advocated for years! So at last, this type of mounting will be available as a commercial product and all those who have trudged through monument makers and marble dealers in vain can rest.

Shure Bros. was at the show in full force with stereo cartridges and mikes. *Harman-Kardon* had many attractive updatings on its integrated amplifier-tuner combinations but most interest centered around the huge 120-watt "Citation" stereo amplifier kit and a new intermediate-size speaker by "Citation" designer, Stu Hegeman. I asked him if he envisioned putting out a commercial version of his fabulously complex "Pro" speaker, but he didn't think the market was ready for it yet.

In the *Hartley* room, they were demonstrating the unique properties of lightness and strength in the special Polymer speaker cones and, at the same time, producing some very clean sound. *Integrand Corp.*, after failing to appear at the last few Shows, finally made the grade with its most unusual speakers driven by separate transistorized servo-type amplifiers that utilized a "sensing device" to control distortion. The result was mighty impressive sound from a moderate sized enclosure. I don't think all the bugs are licked yet, but this is a unit with great potential and I, for one, never feel that what I hear at a Show necessarily represents optimum conditions . . . far better to listen to the particular setup you are interested in at your dealer's, where peace and quiet and relatively stable, predictable conditions prevail.

Karg was showing their clever crystal-controlled FM tuners . . . no excuse for drift here! *KLH* was demonstrating two complete full-range electrostatic units, which were being shown for the first time. To this reporter, the stereo demonstration I heard was disappointing. For one thing, the speakers were set too far apart and I don't think things were working properly. The units stand about 6½ feet high, are about 24 inches wide, and have a depth of only a few inches. This is the way most people have envisioned full-

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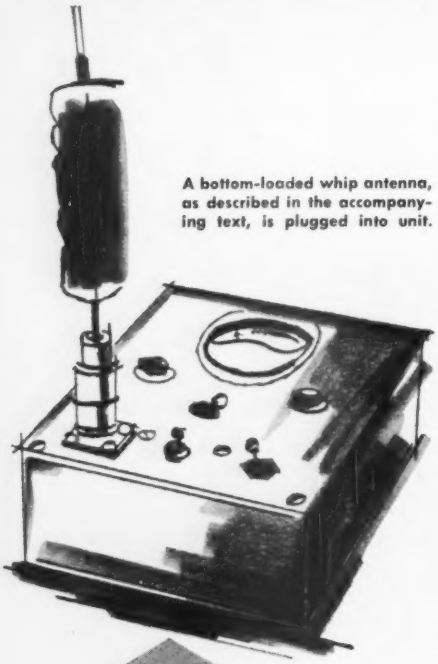
CB FIELD-STRENGTH METER

By LYMAN E. GREENLEE

Complete construction details on a simple and sensitive indicator of relative field strength that may be used to properly tune up your Citizens Band transmitter unit.



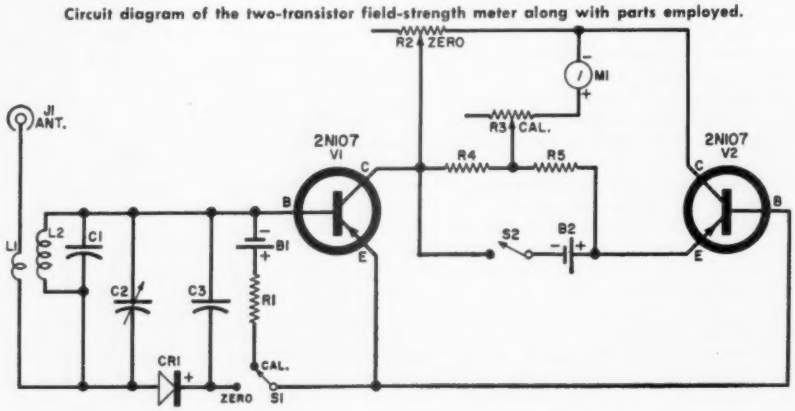
A bottom-loaded whip antenna, as described in the accompanying text, is plugged into unit.

UNDER the new FCC rules it is now legal for an operator to adjust the antenna tuning on Citizens Band transceivers while the transmitter is on the air, provided the transmitter meets certain legal requirements (see "License Not Needed for Citizens Radio Adjustments," page 84, December, 1959 issue). A field-strength meter is necessary for checking out such adjustments to make sure that the maximum signal is being radiated from the antenna. Adjustments *not permitted* are those that might affect the *frequency* of operation, which must be kept within ± .005 per-cent of the assigned channel. A suitable field-strength meter for this purpose can be built easily and at low cost, as will be described below.

The field-strength meter to be described is a bridge circuit using two *G-E* 2N107 or *Raytheon* CK722 *p-n-p* transistors, with a gain of 75:1 (equivalent to 150,000 ohms-per-volt with the 0-500 μa. meter). The tuned circuit is a section of *B & W* "Miniductor" and is made up by cutting 12 turns from a Type 3015 "Miniductor"; with a primary inner winding made of 3 turns clipped from a Type 3011 "Miniductor." The inner winding should be fastened in place with polystyrene coil dope. Leave enough excess wire at each end for leads so that the coil assembly can be soldered directly to a 6-lug wiring tie and be self-supporting. Power is supplied by two small penlite cells. Correct battery polarity *must* be observed.

All parts are mounted on the front panel or on the 1/16" linen Bakelite subpanel as shown in the inside view of the instrument, which is housed in a standard 2" x 5" x 6" Bakelite meter case. Placement of parts is not critical. Note the use of *Cinch-Jones* barrier terminals to mount the two transistors. These terminals are preferable to soldering or to subminiature sockets for mounting transistors in test equipment. When soldering, there is always the danger of ruining the transistor through overheating, and with sockets or clips there is the probability of loose connections or of the transistor actually dropping out of

Circuit diagram of the two-transistor field-strength meter along with parts employed.



R_1—150,000 ohm, ½ w. carbon res. ± 5%
R_2—15,000 ohm wirewound rheostat
R_3—2000 ohm wirewound rheostat
R_4, R_5—1000 ohm, ½ w. carbon res. (matched pair, see text)
C_1—0-4.7 μμf. ceramic capacitor (see text)
C_2—8.7 μμf. var. capacitor (Hammarlund MAC-10, Johnson 9M11, or equiv.)
C_3—.05 μf., 200 v. metallized paper capacitor
L_1, L_2—See text
J_1—Chassis connector (Amphenol 83-1R)
M_1—0-500 μa. meter, 2" round case
S_1—S.p.d.t. toggle switch
S_2—S.p.s.t. toggle switch
B_1, B_2—1.5-volt penlite cell
CR_1—1N34A crystal diode
V_1, V_2—"p-n-p" transistor (G-E 2N107 or equiv.)
1—Bakelite meter case (6-13/16" x 5-9/32" x 2-5/16")
1—Panel for meter case (6½" x 5")
1—Pc. linen Bakelite (4" x 4" x 1/16")
2—Barrier terminals (Cinch-Jones Type 3-140)
1—2-cell battery holder (Acme)

the socket under conditions of severe vibration.

The two 1000-ohm resistors (R_4 and R_5) should be a matched pair. It is more important that they have the *same* value than it is that they should measure exactly 1000 ohms. The two transistors should be matched for gain and leakage. Try different transistors if the meter fails to "zero" properly when R_2 is adjusted, or if it will not read full-scale when R_3 is adjusted.

A standard base-loaded whip for 27 mc. will fit the *Amphenol* connector J_1. (Note: Such a whip may be made of a 38-inch length of stiff wire with a 24-turn coil closewound to an inner diameter of ⅞". Insulated wire should be used for the coil.) Tuning of antenna coil L_2 is by means of capacitor C_2 which is a *Hammarlund* MAC-10 or *Johnson* 9M11. C_1 is 2.7 $\mu\mu$f. in the author's unit but this value should be chosen to center the 27-mc. band so that C_2 will cover all 23 channels with some overlap at each end of the range. Therefore, C_1 may be varied from zero to 4.7 $\mu\mu$f. as required, or C_1 may be replaced with a small ceramic trimmer of 2-6 $\mu\mu$f. in case a fixed capacitor of the right size is not available.

CR_1 may be a Type 1N34A or any similar type of detector diode. Most any diode will work irrespective of type number. C_3 should be a small metalized paper tubular capacitor with low leakage. R_1 is the calibrating resistor and should have a tolerance of ± 5 per-cent or better.

It is suggested that the parts themselves be used as a basis for locating mounting holes. Everything should be placed in position on the panels and outlined with pencil before drilling starts. The sub-panel is held in place by means of the meter studs. Most of the wiring should be completed before the circuit is finally assembled to the meter. Be sure to observe correct polarity when wiring the diode and transistors.

Operation is as follows: Turn the meter on with switch S_2 and allow a minute or so of "warm up" time. During this period the zero setting will shift rapidly and then settle down. With switch S_1 in the "zero" position, adjust the "zero" control, R_2, to bring the meter pointer back to zero. Flip S_1 to the "cal." position and adjust the calibrate control, R_3, until the meter reads full-scale. Go back to the "zero" position with S_1; reset R_2 if necessary and attach the whip antenna. The meter is now ready to measure field-strength.

With a 27-mc. signal, adjust C_2 for maximum meter deflection. S_1 must always be in the "zero" position to read field-strength. For an absolutely accurate setting of the "zero" control, the antenna should be shorted or removed because the meter may read one or two scale divisions from random noise and signals from other 27-mc. transmitters. Random noise will be of little consequence when tuning a transmitter for maximum output from the antenna since operation will be at very close range. It is possible to get a reading a half-mile away from the transmitting antenna and, for close distances, the meter may go off-scale. If the meter goes off-scale, move the field-strength meter away from the transmitter or disconnect the whip antenna and use a short piece of wire.

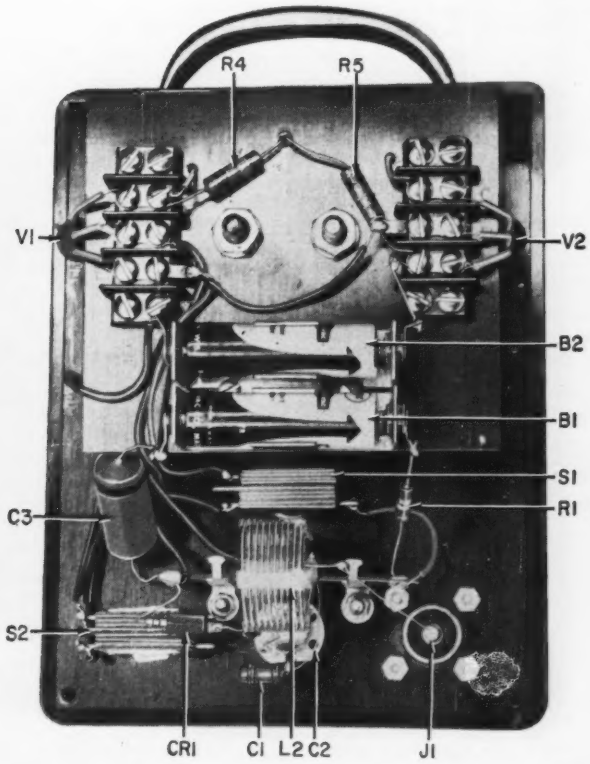
With the meter adjusted for "zero" and "sensitivity," measurements taken in any given location can be duplicated at any future time. Always remember, however, that moving the field-strength meter to a different location, even though it may be only a few inches, will change the reading. Changes in transmitter tuning or antenna adjustments can be checked with a high degree of accuracy, *provided* the field-strength meter is not moved during the adjustments.

To evaluate different antennas and locations, measure off a fixed distance such as 50 feet and use this distance as a basis for all measurements. Keep the field-strength meter a fixed distance above the ground and away from all nearby objects. For transmitter antenna tuning, location of the field-strength meter is of little importance as long as a good readable signal shows on the meter, which should be placed so that it can be read easily as adjustments are being made. With the base-loaded whip, sensitivity is good enough to give a good, readable signal at 1000 feet from the transmitting antenna.

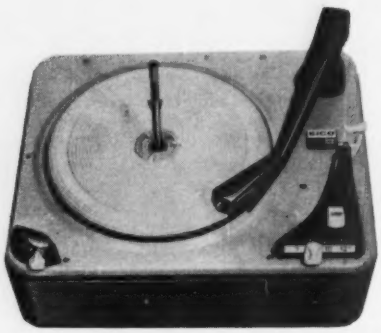
The field-strength meter has proven rugged and reliable in actual use. There is some variation in sensitivity with changes in temperature but this can be easily compensated for by adjusting R_2 and R_3. [30]

Front-panel view of the author's home-built field-strength unit.

Two barrier terminal strips are employed for the interconnections.



Collaro TC-99



Eico 1007

Garrard RC-88/II

Hi-Fi Record Changers

By WARREN DeMOTTE / **Modern record changers have been improved for stereo. Here is the complete run-down on what is available.**

ROTATING a phonograph record and enabling a stylus to pick up the program engraved in its grooves can be accomplished in several ways. The basic components required for this purpose—the turntable and the tone arm (with its phono pickup cartridge)—remain constant, but each may vary in design and, together, they can be combined in different ways to meet different conditions.

The most popular combination of turntable and tone arm is incorporated in the record changer, a device which ingeniously combines all of the functions of record handling, playing, and changing within one integrated unit that operates automatically. Less common are the individual turntable and tone arm and that compromise combination sometimes called, rather unimaginatively, a record player or semi-automatic turntable.

In high-fidelity circles, the individual turntable and tone arm are frequently accorded qualitative precedence over either of the automatic record-handling devices. Some of the reasons for this are that turntables are available in many types, grades of quality, and differences of size and weight. Tone arms appear in an equally large variety and each can be utilized at its optimum operating efficiency without having to trigger an automatic record-changing mechanism.

However, a substantial majority of record collectors are not primarily concerned with the niceties, refinements, and subtleties of what are, to them, merely mechanical means of getting the record into play. They want something simple to operate, foolproof in performance, and convenient in general use.

For them, the record changer offers an ideal realization of their requirements. Once set, it automatically places the stylus on the record easily and accurately and it plays one record after another without further attention. Little skill or facility is required to operate a changer properly. Stacking the records, pressing the right buttons, and turning the right knobs are light tasks anyone can perform. The record changer does the rest and, today, it does it quite well. As a matter of fact, some record-changer manufacturers have striven to produce a product whose performance equals that of some individual turntables and arms. However, it is not logical to expect that any record changer be equal in performance to a professional-type turntable whose cost is considerably above that of the changer and which does not have any automatic facilities.

Stereo Records

With the introduction of the stereo disc, new problems arose in the matter of record reproduction. One of these was the appearance of rumble where little or none had been present before. This nuisance was admitted by the higher vertical compliance of the stereo cartridge, a compliance which was not demanded by the monophonic record and which, therefore, was not incorporated in the monophonic cartridge. High vertical compliance increases rumble and many turntables and changers which functioned entirely satisfactorily with mono records were found less than adequate with stereo records or with mono records played with a stereo cartridge.

As high vertical compliance is a stereo necessity, the situation could be corrected either by a bass cut-off—called a "rumble filter"—or by improv-

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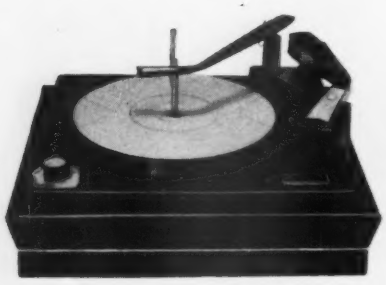
Glaser-Steers GS-77



Heath AD-60

Lesa CD2/21

Hi-Fi Record Changer Check List

NAME	PRICE[1]	DIMENSIONS (Inches)[2]	SPEEDS[3]	AUTOMATIC 45 RPM SPINDLE AVAILABLE	INTERCHANGEABLE CARTRIDGES	INTERMIX (Different Record Sizes)	TYPE OF CHANGER MECHANISM	PLUG-IN SHELL	SPINDLE REMOVAL	AUTOMATIC SHUT-OFF	MUTING SWITCH	MANUAL OPERATION
Collaro TSC-640	$38.50	12 x 13 x 7⅝	4	Yes	Yes	Yes	Overhead Arm	No	No	Yes	Yes	Yes
Collaro TSC-740	$42.50	12 x 13 x 7⅝	4	Yes	Yes	Yes	Overhead Arm	Yes	No	Yes	Yes	Yes
Collaro TC-99	$59.50	12 x 13 x 7⅝	4	Yes	Yes	Yes	Overhead Arm	Yes	No	Yes	Yes	Yes
Elac 1007	D-$59.75 S-$49.75	13 x 10¾ x 8½	4	Yes	No	Yes	Spindle Action	No	Yes	Yes	Yes	Yes
Garrard 210	$49.50	14⅞ x 13 x 8⅛	4	Yes	Yes	Yes	Overhead Arm	Yes	No	Yes	No[9]	Yes
Garrard RC-88/II	$59.50	15½ x 13¼ x 9⅝	4	Yes	Yes	No	Pusher	Yes	Yes	Yes	Yes	Yes
Garrard Type A	$69.50	15 x 13½ x 7⅞	4	Yes	Yes	No	Pusher	Yes	Yes	Yes	Yes	Yes
Glaser-Steers GS-400	$47.50	13½ x 12 x 8½	4	Yes	Yes	Yes	Overhead Arm	No	No	Yes	Yes	Yes
Glaser-Steers GS-77	$59.50	13½ x 12 x 8½	4	Yes	Yes	Yes	Overhead Arm	No	No	Yes	Yes	Yes
Heath AD-50	A-$53.95[4] B-$54.95[4] C-$49.95[4]	13½ x 12 x 8½	4	Yes	Yes	Yes	Overhead Arm	No	No	Yes	Yes	Yes
Heath AD-60	A-$61.95[4] B-$62.95[4] C-$59.95[4]	13½ x 12 x 8½	4	Yes	Yes	Yes	Overhead Arm	No	No	Yes	Yes	Yes
Lesa CD2/21	$44.50	11½ x 13½ x 7¾	4	Yes	Yes	Yes	Overhead Arm	Yes	No	Yes	Yes	Yes
Miracord XS-200	$67.50	10¼ x 12½ x 10¼	4	Yes	Yes	Yes	Spindle Action	Yes	Yes	Yes	Yes	Yes
Norelco AG-1024	$39.50	13¹¹⁄₁₆ x 11⅞ x 7¾	4	Yes	Yes	Yes	Overhead Arm	Yes	Yes	Yes	Yes	Yes
United Audio Dual-1006	$79.95	13 x 10¾ x 8½	4	Yes	Yes	Yes	Spindle Action	No	Yes	Yes	Yes	Yes
V-M 1551	$27.95[5]	12 x 13¼ x 8⅝	4	Yes	Yes	Yes	Overhead Arm	No	No	Yes	No[9]	Yes
V-M 1571	$40.00[6]	12 x 13¼ x 8⅝	4	Yes	Yes	Yes	Overhead Arm	No	No	Yes	No[9]	Yes
V-M 1572	$40.00	12 x 13¼ x 8⅝	4	Yes	Yes	Yes	Overhead Arm	Yes	No	Yes	No[9]	Yes
Webcor TR-1041-27	$44.20	13½ x 14¹¹⁄₁₆ x 9½	4	Yes	Yes	Yes	Overhead Arm	Yes	No	Yes	No[9]	Yes
Webcor TR-1041-1	$45.75[7]	13½ x 14¹¹⁄₁₆ x 9½	4	Yes	Yes	Yes	Overhead Arm	No	No	Yes	No[9]	Yes
Webcor 1031-27	$49.38	13½ x 14¹¹⁄₁₆ x 9½	4	Yes	Yes	Yes	Overhead Arm	Yes	No	Yes	No[9]	Yes
Webcor 1031-1	$60.43[8]	13½ x 14¹¹⁄₁₆ x 9¼	4	Yes	Yes	Yes	Overhead Arm	No	No	Yes	No[9]	Yes

SYMBOLS:

D. Including turnover cartridge and diamond/sapphire styli.
S. Including turnover cartridge and sapphire styli.
A. Including G-E VR-227 cartridge and diamond stylus.
B. Including Shure M8D cartridge and diamond stylus.
C. Including Sonotone 8TA4-SD cartridge and diamond/sapphire styli.

NOTES:

1. Less cartridge and base.
2. Width, depth, and over-all height (below and above deck).
3. 78, 45, 33⅓, and 16⅔ rpm.
4. Kit.
5. Including turnover cartridge and sapphire styli.
6. Including turnover cartridge and diamond/sapphire styli.
7. Including Astatic turnover cartridge and diamond/sapphire styli. TR-1041-21 includes G-E cartridge and diamond stylus ($60.60).
8. Including Sonotone turnover cartridge and diamond/sapphire styli. 1031-21 includes Shure cartridge and diamond stylus ($67.05).
9. No audible electrical noise produced during change cycle.

Miracord XS-200

Norelco AG-1024

United Audio 1006

ing the design of the turntable or changer. The first method is wasteful and unsatisfactory in a high-fidelity system. Cutting off bass tones to eliminate rumble also means eliminating one of the most attractive features of high-fidelity reproduction—the ability to hear bass tones with clarity. For this reason, it was found more advantageous and more practical to follow the second course and cut out rumble through improvement in design. Thanks to such engineering improvements, many changers today operate more effectively than some of the expensive turntables did during mono days.

Virtually all record changers carry manufacturers' specifications which indicate that they will not introduce objectionable rumble into the average hi-fi system. However, where the system includes speakers with very good bass response, theory sometimes gives way to fact and it is wise when buying a changer to ask that it be demonstrated in conjunction with speakers and an amplifier—preferably similar to those you own. You can then hear if the changer introduces any rumble or not.

The most important function of a turntable—whether a separate unit or incorporated in a changer—is to rotate the record at a constant speed. Deviations from constant speed show up as annoying changes of pitch known as "wow" and "flutter." Piano tones are particularly affected by this operational defect and a simple test to uncover it is to play a recording of slow piano music. The piano tones should be firm and incisive. If they sound "watery" and quavery, the changer turntable is, of course, unsatisfactory.

When making this test, it is advisable to stack several records on the changer, perhaps to capacity, with the test record last. If the sound of the test record is good, this is also an indication that the motor is powerful enough to function properly with more than one or two records on the platter. A weak motor is quickly exposed by means of this test.

Record Changing Methods

There are three common ways in which the records are changed: one is by pushing, the other two completely by spindle action. Of these, the pusher-type usually employs a bent spindle. In all instances the records are stacked on a discontinuity or step high on the spindle. In two types, they are further supported by either an overhead arm or a pusher platform. The third type has a straight spindle with projecting prongs that support the record stack and retract momentarily within the spindle to let the bottom record drop. The prongs then return rapidly to their original position to support the remaining records.

In purchasing a changer, it is wise to observe the change cycle in action with a stack of records. The actual changing process should be smooth, without sticking. If there is sticking during the change cycle, damage will be inflicted on the records and perhaps on the stylus and cartridge.

There are some changers which will operate automatically with records of various sizes intermixed in any order. Other changers will do the same with different size records, but only when the largest discs are placed at the bottom of the stack and the remainder stacked in order of decreasing size. Still other changers will play only one size of record per sequence. Of course, in all instances, the stack must be made up of records of the same speed.

Speeds and Cartridges

Most changers will operate at all four record speeds: 78, 45, 33⅓, and 16⅔ rpm. Very few records are available at the slowest speed and, except for speech, 16⅔ rpm is not likely to be used any more extensively in the near future. Some changers employ an extra center-drop automatic spindle for playing 45's; others use the regular changer mechanism and spindle, requiring small adapters be inserted in the larger holes of the discs. The first method is much more convenient in cases where the record collection contains many 45's which are played frequently.

Most changers will accept standard cartridges, but some will not function properly at the very light tracking pressures of a few very high compliance cartridges. This limitation is caused by the arm's having to trip the change mechanism. It is not too serious a limitation, however, as changers now have far more sensitive trips than formerly and most of them function at light enough pressures to accommodate very fine cartridges. Along these lines some manufacturers of cartridges make two slightly different models of a given cartridge type, one specifically designed for record-changer use and the other for separate tone arms. On the other hand, there are some changer manufacturers who claim that their tripping mechanism is sensitive enough to permit stylus pressures that are limited solely by the design of the cartridge itself.

Changers with removable spindles are more convenient to use than those with permanently placed spindles. A removable spindle simplifies record removal. Changers that employ short, straight spindles for single record playing are also more convenient. Another simple convenience is facilities for manual operation when this is desired and a reasonable requirement is automatic shut-off after the last record is played. Another reasonable requirement is a muting arrangement in the changer's electrical circuit so that the change cycle does not cause clicking and popping noises to come through the speakers. There are, however, some changers which, since the manufacturers claim there is little or no electrical noise during the change cycle, employ no muting switch. Of course, the mechanical operation of the changer should be reasonably quiet; clatter and grinding are signs of poor design and perhaps careless workmanship.

No record changer should be asked to do what it has not been designed to do. Records that are very warped

(*Continued on page* 98)

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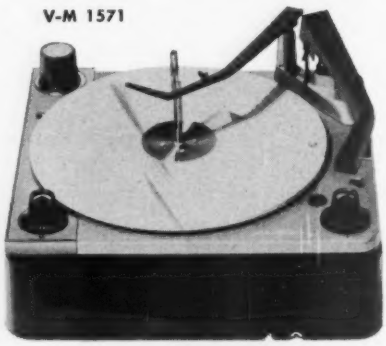

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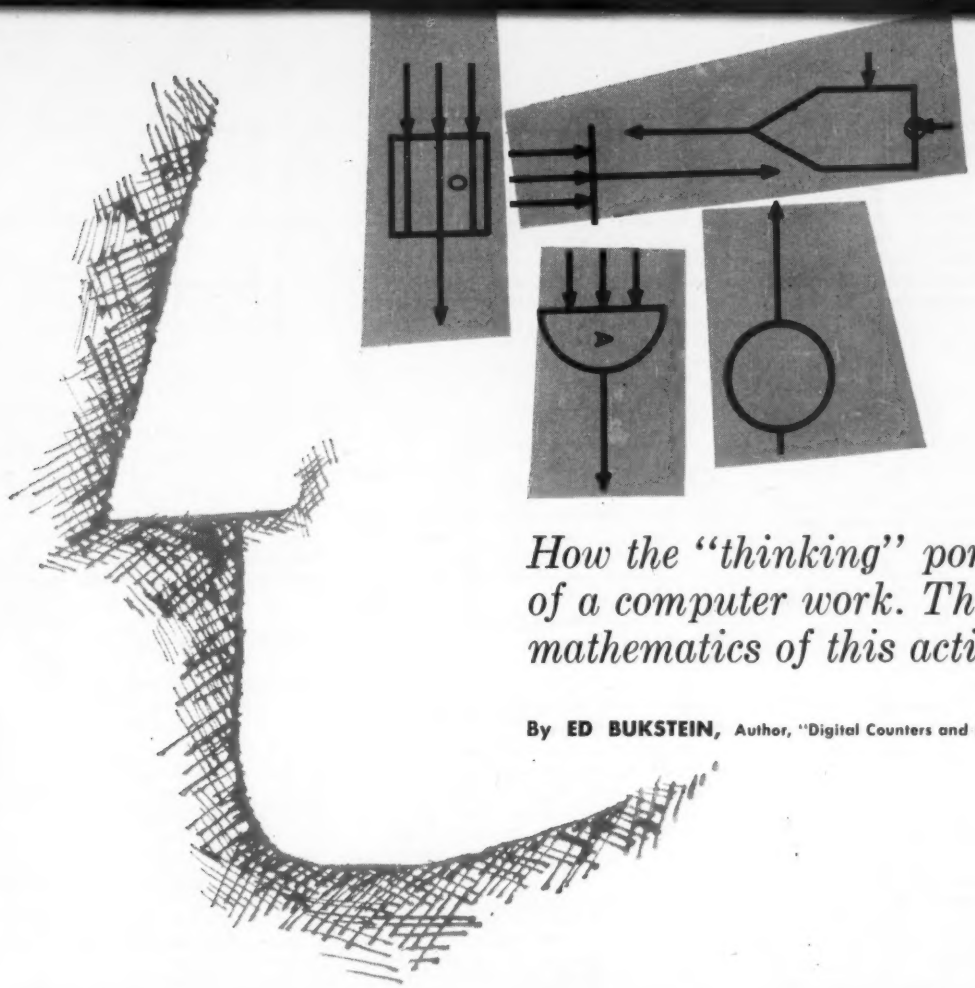


How the "thinking" portions of a computer work. The mathematics of this action.

By **ED BUKSTEIN,** Author, "Digital Counters and Computers"

Computer Logic Elements

DOES AN electronic computer actually *think?* This has been a subject of controversy, and the answer depends on how you define the word *think.* An electronic computer can make decisions. It can recognize and accept the input information it receives; it can classify, sort, and manipulate this information; it can compare the information with other information previously stored in its memory; and, on the basis of this comparison, it can decide what to do next. If you regard this type of activity as thinking, then the computer can indeed think. The portion of the computer's anatomy that does this thinking is the logic circuitry.

Logic circuits are of three basic types: the *and* circuit, the *or* circuit, and the *not* or *inverter* circuit. The *and* circuit has two or more input terminals and produces an output only when an input is present at *all* of its input terminals. For this reason the *and* circuit is sometimes referred to as a *coincidence* circuit: input signals must be present at all input terminals *at the same time.* Two other names for this same circuit are *and gate* and *logical and* circuit.

Fig. 1. The "and" circuit has 2 (or more) input terminals, produces output only when all terminals (B, D) are activated. Switches (A, B) symbolize action, but signal pulses (C, D) are used in practice.

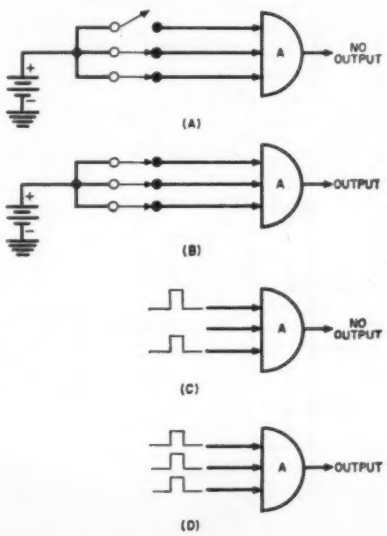


Fig. 1A shows a three-input *and* circuit. With the switches in the positions shown, input is applied to only two of the three input terminals and the circuit therefore produces no output. An output can be obtained from this circuit only when *all* inputs are active, as shown in Fig. 1B. *And* circuits can be designed to respond to d.c. inputs, as shown in Fig. 1B, or to pulse inputs, as shown in Fig. 1D. Furthermore, the circuit can be designed to respond to negative input pulses rather than the positive ones shown in Figs. 1C and 1D.

The *or* circuit has two or more input terminals and produces an output when input is applied to *at least one* of the input terminals. The *or* circuit (Fig. 2) can be designed to respond to either d.c. or pulse-type inputs, and can be designed to respond to negative rather than the positive inputs shown in Fig. 2C.

In its simplest form, the *or* circuit would consist of several pieces of wire connecting various input terminals to a common output terminal. This form of *or* circuit, however, would not be practical because it would permit undesired interactions between the external cir-

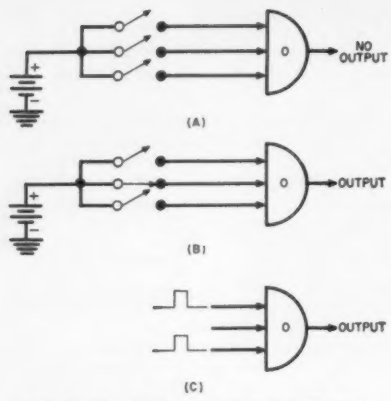


Fig. 2. The "or" circuit has 2 (or more) input terminals, produces an output when at least one input (or more) is active.

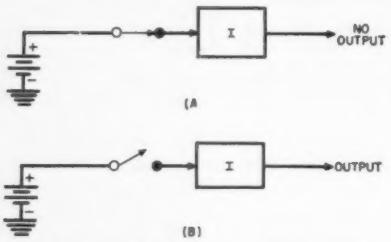


Fig. 3. Inverter or "not" circuit yields output only when there is no input at all.

cuits used to supply the inputs. A practical *or* circuit should provide isolation to prevent the input applied to one of the terminals from appearing at the other input terminals. For this reason the *or* circuit is sometimes referred to as a *buffer*.

The *inverter*, another logic circuit, is also known as a *not* circuit. As shown in Fig. 3, this circuit produces an output when an input is *not* applied. If an input is applied, the circuit produces no output. The circuit therefore represents the function of *negation* or *inversion*.

The Inhibitor

The inhibitor, used extensively in computer circuitry, can be represented as a combination of an *and* circuit and an *inverter*. As shown in Fig. 4, the output terminal of the inverter is connected to one of the input terminals of the *and* circuit. Since the *inverter* produces an output only when it receives no input (Fig. 4B), the *and* circuit cannot produce an output when the inverter receives an input (Fig. 4A). The same technique can be used with *and* circuits having more than two input terminals, as shown in Fig. 4C. This circuit produces an output when input is applied to all terminals *except* the one which feeds the inverter. The inhibitor circuit is often represented by a single block as shown in Fig. 4D.

Combination Logic Circuits

And, *or*, and *inverter* circuits may be connected in various combinations to produce specific, desired effects. As an example, assume that a circuit is to produce an output when it receives an input at either one but not both of its two input terminals. Fig. 5A shows a combination of logic circuits that satisfies this requirement. For identification, the input terminals are labeled A and B, and the output terminal is labeled C.

If an input is applied to either A or B (but not both) an output will appear at terminal C. If inputs are applied to both A and B, no output will appear at C because (1) the *and* circuit which feeds into the inverter will produce an output; (2) the inverter will produce no output because it receives an input; (3) since the inverter produces no output, the

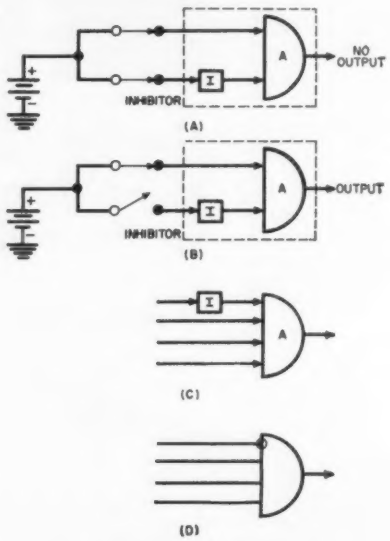
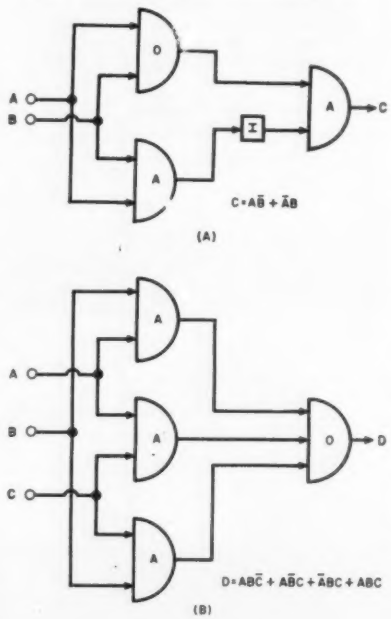


Fig. 4. Action of the inhibitor (A, B). It combines the inverter with the "and" element. More than one symbol may be used to represent this combination. Two of several in use (C, D) are shown here.

Fig. 5. Various logic elements can be combined to produce characteristics, with respect to input conditions, that are not available from single elements. See text.



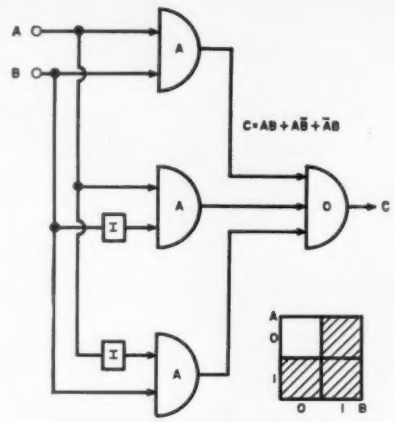


Fig. 6. Characteristics of a logic circuit may be shown by Boolean formula (upper right) or a truth table (lower right).

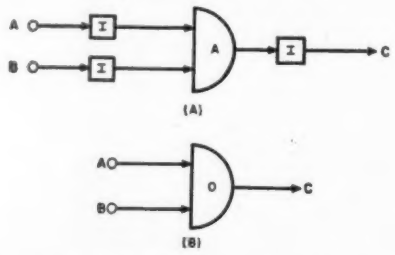


Fig. 7. A truth table can be used to simplify logic circuitry. Configuration of (A) can be reduced to that of (B). Both exhibit the same over-all behavior.

and circuit that follows produces none.

This circuit arrangement is sometimes referred to as an *exclusive or* circuit because of its one-or-the-other-but-not-both characteristic. Mathematically, the circuit of Fig. 5A is described by the equation, $C = A \times \bar{B} + \bar{A} \times B$.

In this form of notation (Boolean algebra) the plus sign (+) means *or*, the multiplication sign (×) means *and*, and the bar over a letter means *not*. The above equation therefore means that an output will appear at terminal C if an input is applied to A and not B, or to B and not A. As in other forms of algebra, the multiplication sign can be omitted. The equation then becomes $C = A\bar{B} + \bar{A}B$.

The circuit shown in Fig. 5B has three input terminals identified as A, B, and C. Each of the *and* circuits is connected to two of the three input terminals. The upper *and* will respond to A and B, the center *and* responds to A and C, and the lower *and* produces an output in response to inputs to B and C. If inputs are applied to any two of the three input terminals, the corresponding *and* circuit will produce an output. This output is applied to the *or* circuit, producing an output at terminal D. If inputs are applied to all three input terminals, all three *and* circuits will produce outputs and a signal will also appear at terminal D. The Boolean equation for this circuit is therefore $D = AB\bar{C} + A\bar{B}C + \bar{A}BC + ABC$.

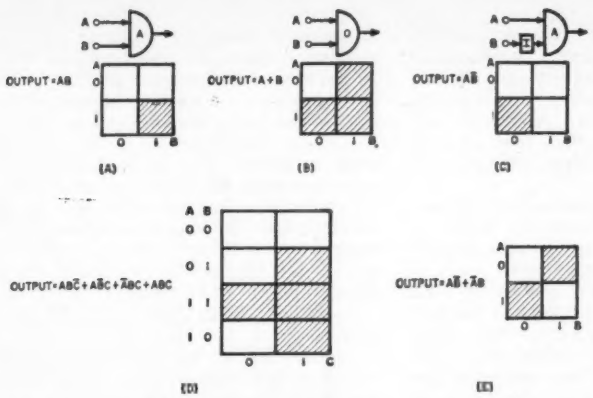


Fig. 8. Truth tables show all possible input conditions that will produce output in logic elements or circuits. Three of these are shown (A, B, C) below the elements whose action they depict. The other two pertain to circuits discussed earlier. These are Fig. 5B (D) & Fig. 5A (E).

This is read: D is equal to A and B and not C; *or* A and C and not B; *or* B and C and not A; *or* A and B and C. The circuit therefore produces an output for any combination of two inputs or for all three inputs.

Truth Tables

A truth table is a graphical representation of the characteristics of a logic circuit. Consider, for example, the logic circuit and truth table shown in Fig. 6. The three *and* circuits produce outputs for (1) A and B, (2) A and not B, or (3) B and not A. The Boolean equation of this circuit is $C = AB + A\bar{B} + \bar{A}B$.

These characteristics of the circuit are shown in the truth table to the lower right in Fig. 6. The symbols 1 and 0 represent *input* and *no input* respectively, and the shaded squares represent conditions which produce output. The output produced when input is applied to terminal A but not to terminal B ($A = 1, B = 0$) is represented by the shaded square in the lower left corner. The square at the lower right shows that output is produced when inputs are applied to both A and B ($A = 1, B = 1$). The shaded square at the upper right represents $A = 0, B = 1$.

The truth table is useful because it may suggest a way of simplifying the circuit while retaining the same over-all characteristics. An examination of the table in Fig. 6, for example, reveals that the circuit will produce an output for all conditions except $A = 0, B = 0$. This suggests a circuit arrangement such as that shown in Fig. 7A. If A and B are both 0 (no inputs) the two inverters will both produce outputs. With inputs thus available for both of its terminals, the following *and* circuit produces an output. Since the final inverter receives an input, there is no output at terminal C. The circuit is therefore equivalent in performance to Fig. 6, but requires fewer blocks.

Actually, the circuit can be still further simplified. Another examination of the truth table in Fig. 6 shows that the circuit produces output when it receives *at least one* input (either A or B or both). Since this is the characteristic of a simple *or* circuit, Fig. 6 is eventually reduced to the circuit of Fig. 7B!

In the design of computer circuits involving literally thousands of logic elements, the truth-table method of approach often permits tremendous simplification of over-all circuitry. Fig. 8 shows the truth tables for simple (A) *and*, (B) *or*, and (C) inhibitor circuits, and also for circuits shown in Fig. 5. Fig. 8D is the table for Fig. 5B; Fig. 8E is the truth table for Fig. 5A.

Boolean algebra is a type of algebra that is particularly well-suited to the design and analysis of logic circuits. Like the truth table, Boolean algebra can suggest possible circuit simplifications. The Boolean equation of a circuit can be manipulated mathematically, as are other algebraic equations, so that it is eventually simplified and suggestive of a simpler circuit configuration. Consider, for example, Fig. 10A.

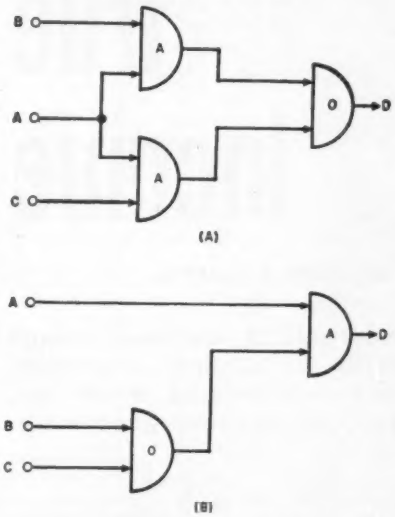
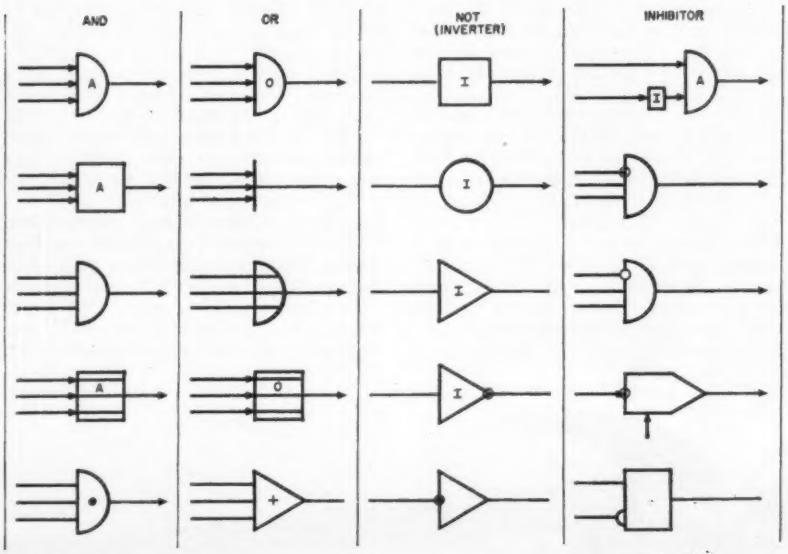


Fig. 10. Manipulation of Boolean equations can help simplify circuitry. Both circuits shown here behave the same way.

One of the *and* circuits yields an output for A *and* B, and the other produces output for A *and* C. The output at D can therefore be expressed as $D = AB + AC$. This equation however, can be simplified to $D = A(B+C)$, which suggests that the B and C terminals can be connected to an *or* (+) circuit, and this output can be *anded* with A. The resulting simplification, shown in Fig. 10B, provides the same behavior as the arrangement of Fig. 10A. Although the reduction of circuitry may not seem particularly impressive in this example, equipment involving elaborate logic circuitry can be greatly simplified by the methods of Boolean algebra.

Fig. 9. Symbols for logic circuitry have not yet been standardized. However the most commonly used symbols for four principal logic elements are tabulated here.



Symbols

Although there have been some attempts to standardize the symbols used to represent logic circuits, such standardization has not yet been achieved. Various symbols are therefore used by different manufacturers and designers to represent the same logic elements. Some commonly used symbols are shown in Fig. 9.

This article has dealt with logic circuits in block diagram form. A later article will deal with the actual circuit diagrams of logic elements and with the use of these elements in the arithmetic section of a computer. [30]

Determine Your True Income

By **JOHN E. FLIPPIN**

How well is your shop doing? With an income statement, not difficult to draw up, you can eliminate guesswork.

MOST INDEPENDENT service technicians have found themselves, at one time or another, in a baffling position. Although they are working strenuously to improve their situations, they seem to be standing still or even falling back. Take the hypothetical case of Joe Smith.

For a few years, Joe has been dreaming of the day when he can make his way exclusively as a full-time service dealer. Right now, although he does own a small shop, he can only work out of it part-time: he couldn't support his family without the salary from his regular job. Joe is an honest man and technically competent, but somehow this has not been enough. He is no closer to his goal than he was a few years ago. In fact, facing the situation squarely, he doesn't even know for sure whether he is making money or not.

His predicament is not unique. Furthermore, it isn't peculiar to his type of operation. Many owners of established, full-time shops have entertained similar doubts.

The trouble is that Joe Smith has no means for determining how well his business is doing. You can't put a scope or a voltmeter on a business to find out what is wrong. You can't isolate clues in the form of volts, ohms, or waveforms. A business is measured in terms of dollars, and these dollars are of various types. For example, there are income dollars and expense dollars. You have to understand these to get started in the right direction. You have to remember that you are in business primarily to make money.

Now Joe is not lacking in intelligence by any means. He's a whiz at getting a sick TV set back into shape. Anyone who can do that has not only invested a lot of time and energy but must be quite sharp. Yet for some reason, when it comes to dollars and cents, a mental block sets in. This is unfortunate, since good business practices are no more complicated than the techniques used in running down faulty oscillators or weak amplifiers.

Before tackling a strange set, the wise technician may want to consult a useful record concerning it—the service manual—to get an idea of what is going on. To get an idea of what your true income is, you must also be able to consult some sort of record. This can be a complete set of formal accounting records or simply a drawer full of bits of paper, but a record of some kind there must be.

In accounting practice, a record of income is known as an Income Statement. Despite minor variations, it should resemble the one shown in Table 1 for a service business. Our purpose is to make this statement sufficiently meaningful to the technician so that he can use it in understanding the business end of running a shop. Its fundamentals will be illustrated through the practical examples of Joe Smith's calculations, after he has learned about record-keeping.

A main function of the income statement is to arrive at a figure for Net Income covering a specific period during which the shop has been doing business. A convenient period is six months. However, it can be longer or shorter depending on the interest and time the shop owner has for such tasks as taking inventory or tabulating sales and expenses.

The salient entries on the statement (Table 1) are: Sales, Cost of Goods Sold, Gross Profit on Sales, Operating Expenses, and, of course, Net Income. Just as the formulas for Ohm's Law and other electronic phenomena help us to analyze technical situations, we can use formulas to clarify certain economic relationships. Here are two important ones:

Sales − Cost of Goods Sold = Gross Profit on Sales ..... (1)

Gross Profit on Sales − Operating Expenses = Net Income ..... (2)

There may be some confusion at first over the meaning of these formulas and the terms used in them, but they should yield to explanation. Take the first item mentioned, Sales.

For the purpose of this statement, it is convenient to lump together under this heading all money that comes in from customers, without differentiating the portion derived from the sale of labor or service from that derived from the sale of goods. Joe Smith has come up with a figure of $4300 for total sales during the period of January 1, 1960 through June 30, 1960. He has arrived at this amount by combining the separate figures shown in Table 2. The separate items you start out with may be a little different. Perhaps you group things differently or don't sell radio and TV sets. But your total should include all sources.

While this figure is important to the income statement, it doesn't tell much by itself. That is why it is a mistake to make plans, as many service dealers do, using this figure alone. It is especially disheartening if Total Sales looks good but there is a meager bank balance to show for it. To improve the ratio between bank balance and sales, other computations must first be made, the next of which is Cost of Goods Sold.

The latter term means simply what you paid for parts or other merchandise sold to customers. It is obtained by first adding the cost of purchases made during the period (including freight costs, where they are billed separately) to the value of material already on hand at the beginning of the period (January 1,

SALES			$4300.00
COST OF GOODS SOLD			
Inventory Jan. 1, 1960		$3300.00	
Purchases	$740.00		
Freight	10.00		
Delivered Cost of Purchases		750.00	
Goods Available for Sale		4050.00	
Deduct Inventory June 30, 1960		−1700.00	
TOTAL COST OF GOODS SOLD			−2350.00
GROSS PROFIT ON SALES			$1950.00
OPERATING EXPENSES			− 750.00
NET INCOME			$1200.00

Table 1. Joe Smith's completed Income Statement for 6 months ending June 30, 1960.

Quantity	Item	Retail Price Each	Total
10	Television sets	$250.00	$2500.00
2	Radios	30.00	60.00
100	Service calls (including parts)		1540.00
	Miscellaneous, over-the-counter sales		200.00
	Total Sales		$4300.00

Table 2. How Joe determined his shop's Total Sales during the statement period.

1960) as determined by the inventory you took on that date. This sum becomes Goods Available for Sale, or the value of merchandise that was in the shop during the period covered.

The last step in determining Cost of Goods Sold is to deduct your end-of-period inventory (June 30) from Goods Available for Sale. The complete sequence in arriving at the figure may be summed up in two more formulas:

Beginning Inventory + Purchases = Goods Available for Sale . . . . . (3)

Goods Available for Sale − Ending Inventory = Cost of Goods Sold . . . (4)

In Joe Smith's case, Table 1 shows that he sold goods costing $2350. Let's see how he got this figure. On January 1, he had taken a count of merchandise on hand and, checking against bills and invoices, established a figure for his beginning inventory. It looked something like Table 3. He simplified things by grouping together replacement components and the like as Miscellaneous Parts. You might want to add such categories as batteries and antennas, but remember that Joe's shop is a modest one and that we only need simple examples for illustration.

To determine how much of this merchandise he bought during the six-month period, he took out all invoices dated from January 1 and later. He did this on June 30. The results appear as Table 4. Applying Formula (3), he added the final figures of Tables 3 and 4 ($3300 + $750) to find out that Goods Available for Sale came to $4050.

On June 30, he also took a physical count of all merchandise on hand and determined its value from invoices to get his final inventory, which is shown as Table 5. Now he was ready to use Formula (4) to determine the Cost of Goods Sold ($4050 − $1700 = $2350).

This put him in the position to learn the first important thing about his operations, his Gross Profit on Sales, because he now had the figures needed for Formula (1). Deducting his $2350 Cost of Goods Sold from his $4300 Sales, he found that Gross Profit was $1950. Actually, he was able to do this conveniently in the last column of his income statement (Table 1).

To establish his Net Income, as per Formula (2), Joe need only determine his Operating Expenses and deduct this amount from Gross Profit. In going through his drawer full of bills and other papers, he was able to pin down seven distinct types of expenses that would recur in every accounting period and are substantial enough to warrant separate listing (Table 6). The Miscellaneous category was to allow for small, irregular expenditures that are hard to classify in other ways, like having Jimmy Jones wash the shop windows. In a one-man, part-time shop, Joe had no payroll to worry about, but he could have included that expense here if it existed.

The $750 total includes what was spent in maintaining the shop and getting to and from customers on house calls. Except for depreciation, the items are fairly straightforward. Determining depreciation—the loss that was incurred from six months wear and tear on shop equipment and the truck—required more calculation.

Since it was the same method used by his accountant in working out his income-tax statement, Joe conveniently used the "straight-line" method for computing depreciation. This means he took the value of all equipment he owned (as distinguished from goods or merchandise for sale) as a starting point. This included all test instruments and tools used in his work. He then made an estimate of how long this equipment could be expected to last. For simplicity, let us say that he concluded all equipment would last for five more years. Since he spent $600 for equipment, depreciation for a single year was one-fifth of this, or $120. However, the period covered by Joe's Income Statement is only half a year, so the figure he entered in Table 6 is $60.

The used truck that he had recently purchased for $600 and which he expected to last for five years was handled in a similar way. This involved another $60 in operating expenses for Table 6. His total, which came to $750, was then transferred to the Income Statement itself (Table 1). Deducting this from his Gross Profit, he obtained a Net Income of $1200 to complete the statement.

Although the statement is completed, it is not an end in itself. Actually, it is the starting point for many other possibilities. For one thing, the figures obtained will be necessary or useful for income-tax purposes. For another, it will help him decide whether he should stay in business or direct his efforts to more promising directions. In addition, if he decides to continue his attempt to build up a successful business, he has figures with which he can experiment to see what he must do to improve.

To convert his income figure into a more universally understood form, Joe's next step involved finding out how much he made on an hourly basis. However, to do this realistically, he was advised to make one other deduction. For the sake of simplicity, consider that the only funds Joe had tied up in his business were the $1200 he had spent for the truck and other equipment and the

(*Continued on page 94*)

Quantity	Item	Cost Each	Total
12	Television sets	$200.00	$2400.00
5	Radios	20.00	100.00
250	Vacuum tubes		375.00
10	Picture tubes	20.00	200.00
	Miscellaneous parts		225.00
	Total		$3300.00

Table 3. Starting inventory for statement period showed goods on hand on January 1.

Quantity	Item	Cost Each	Total
3	Television sets	$200.00	$600.00
2	Radios	20.00	40.00
20	Vacuum tubes		30.00
2	Picture tubes	20.00	40.00
	Miscellaneous parts		30.00
	Total Purchases		$740.00
	Freight		10.00
	Delivered Cost of Purchases		$750.00

Table 4. This tabulation shows cost only of goods bought during statement period.

Quantity	Item	Cost Each	Total
5	Television sets	$200.00	$1000.00
5	Radios	20.00	100.00
170	Vacuum tubes		200.00
10	Picture tubes	20.00	200.00
	Miscellaneous parts		200.00
	Total Final Inventory		$1700.00

Table 5. Cost of goods on hand at end of statement period. This is final inventory.

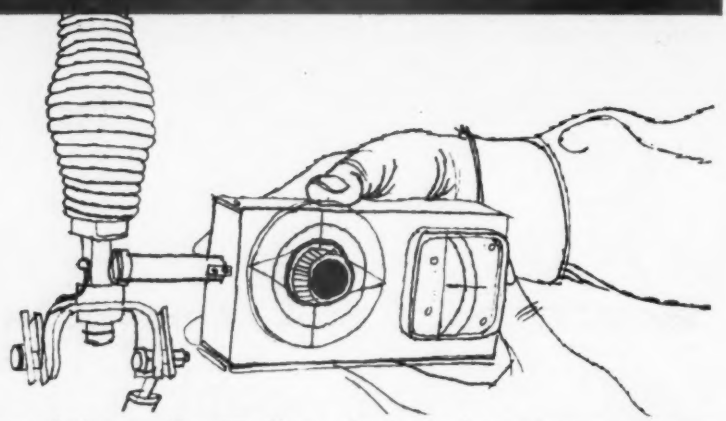
Table 6. Expenses during period. Deduct from Gross Income to find Net Profit.

Item	Amount	Description and Examples
Utilities	$40.00	Electric, gas, telephone, heating
Transportation	150.00	Gasoline, oil, truck repairs
Shop Supplies	20.00	Light bulbs, stationery, solder, wire
Rent	210.00	
Depreciation (equipment)	60.00	See text
Depreciation (truck)	60.00	See text
Advertising	200.00	Newspaper, yellow pages, hand bills, direct mail
Miscellaneous expense	10.00	Washing windows, other incidentals
Total Operating Expenses	$750.00	

The Grid-Dip Meter

By **LOU DEZETTEL, W9SFW**
Allied Radio Corporation

A simple, versatile piece of test equipment that's enjoying renewed popularity among new hams and students.



VERSATILE, simple, reliable, accurate, inexpensive. These adjectives explain why the grid-dip oscillator has been a popular test instrument with hams, students, experimenters, and technicians for more than four decades. Currently, it is being discovered all over again by the army of new hams who are swelling the FCC license lists to new highs. The fact that a grid-dipper is a virtually foolproof home-assembly project also helps to endear it to the present generation of kit-conscious radio buyers.

Basically a tunable oscillator, the grid-dip meter is used primarily to determine the resonant frequency of *LC* (inductance-capacitance) combinations found in communications equipment. It functions in either an active or passive manner, depending on whether the circuit undergoing investigation is itself passive or active. A description of how a typical dipper works will help make these distinctions clear.

Fig. 1 is a complete schematic of an actual grid-dip meter. A single 6AF4A triode, V_1, is the heart of the circuit. Its heater is energized by a low-voltage winding on a small power transformer, T_1. Plate voltage is derived from a high-voltage winding in combination with a half-wave selenium rectifier, CR_1, filter capacitor C_3, and potentiometer R_3. Maximum voltage between the arm of R_3 and ground is 120 to 130 volts. The a.c. line switch, S_1, is combined with R_3.

An untapped plug-in coil (L_1 through L_6, with frequency ranges as listed) is tuned by split variable capacitor C_{1A},C_{1B}. Oscillation in L_1,C_1 takes place because the voltage applied to the grid by C_{1B} is 180 degrees out-of-phase with that on the plate, across C_{1A}. This capacitively coupled circuit is known as the Colpitts oscillator. The fixed capacitor C_2 keeps the d.c. plate voltage off the grid of the tube but does not affect the r.f. functioning of L_1, C_1.

The grid of V_1 is driven positive during one portion of the r.f. cycle and attracts electrons from the cathode during that interval. This flow shows on meter M_1 as an average d.c. current. Changing the plate voltage by means of R_3 changes the intensity of oscillation and this is reflected in variations in the meter readings.

Operation

Coil L_1 is in the open at one end of the dipper's case, so that it can be placed in inductive relation to the coil of an *LC* circuit of unknown frequency. See Fig. 2. If the latter circuit is passive (that is, not energized in any way), the technique is to turn on the grid-dip oscillator, adjust the plate voltage for a meter reading well up scale and then tune C_1. When the frequency of L_1,C_1 equals that of the unknown *LC*, the latter circuit absorbs energy from the oscillator. This effect shows up as a sharp dip in the grid current reading; hence the name of the instrument. The unknown frequency is merely read from the calibrated scale of the dipper. It is desirable to use the loosest possible coupling between the search coil and the fixed coil, as this minimizes the possibility of false readings due to mutual inductance and capacitance effects.

It is usually possible to approximate the range of the unknown resonant frequency, from the size of the *L* and *C* components or from the general nature of the equipment. When a completely blind search must be made, it is advisable to start with the lowest frequency coil and work upward until a dip is obtained. It is not unusual to observe two or more dips as the oscillator dial is swept around. The sharpest drop represents the fundamental frequency; the

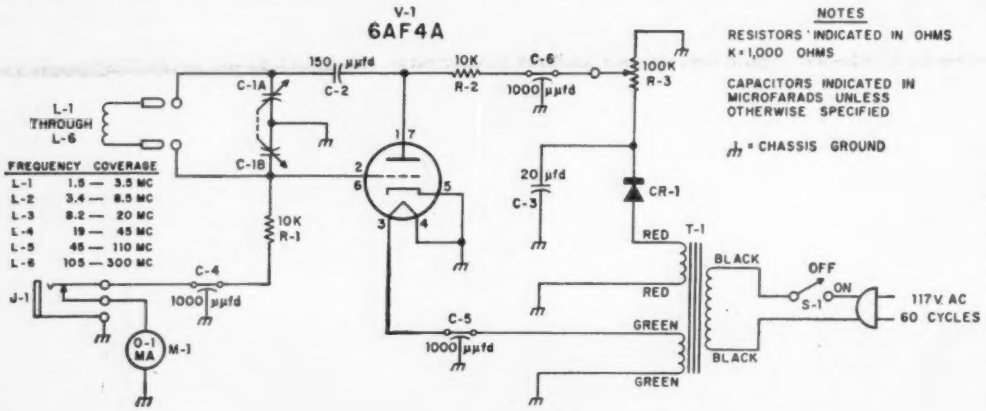


Fig. 1. Complete circuit diagram of a typical grid-dip oscillator. Such a unit is useful to hams, experimenters, and technicians.

others are noticeably weaker and are due to harmonics which are easily identified because of their arithmetical relationship to the fundamental.

Used in a passive role, the grid-dipper is an ideal absorption wavemeter for determining the frequency of an active r.f. source in a transmitter or receiver. The plate voltage on the tube is cut to zero by means of potentiometer R_2, thus killing oscillation. However, since the heater is still on, the cathode and the grid can act together as a simple diode rectifier. When the search coil is brought near the active r.f. source and C_1 approaches resonance, the L_1C_1 circuit absorbs energy from the source. This is rectified by the diode and shows on the meter as an average d.c. current. The needle movement is upward and at resonance the reading is maximum. As before, the loosest coupling consistent with a sharp peak gives the most accurate results.

Plugging a pair of earphones into jack J_1 isolates meter M_1 and converts the dipper into a monitoring receiver. This function is especially useful for checking the frequency of an r.f. source that is too weak to produce a reading of grid current. If the r.f. source is modulated, the plate voltage on V_1 must be cut by R_2, to make the tube act as a straight diode. A critical value of plate voltage, carefully brought up with R_2, again makes the tube act as a normal triode, in a regenerative state; this greatly improves the strength of modulated signals.

For checking an unmodulated source, R_2 is advanced for full oscillation and the tuning capacitor C_1 is adjusted for zero-beat; that is, the frequency of the dipper is made exactly equal to the frequency of the unknown source. Just off zero-beat, in either direction, whistles are heard. These are due to the combining effect of the fixed-frequency signal and the slightly differing dipper frequencies.

A measuring device is no better than its own calibration. In the case of grid-dippers assembled from kits there are bound to be variations. Fortunately, it is quite easy to check calibration by zero-beating a dipper against receivers of various kinds, tuned to stations of known frequency. They're on the air by the hundreds.

Other Applications

In at least one grid-dipper (the "Knight-Kit" Model G-30), the two-prong receptacle for the search coils has a pin spacing of .486 inch, and it therefore accommodates standard crystal holders. With crystals plugged in, the instrument becomes a highly accurate signal source by itself. Capacitor C_1 is left at minimum capacitance; it does not affect the output. As a crystal oscillator, the dipper is extremely valuable for marking the edges of the ham bands.

While a grid-dip oscillator can be used as an emergency signal generator for limited receiver adjustment, its real field of application is transmitters. In a multi-stage transmitter, it greatly facilitates the tuning of oscillator, buffer, doubler, driver, and final stages to the correct frequencies; it makes neutralization quick and easy; it detects bothersome parasitic oscillations. It also measures the resonant frequencies of antennas and helps in the adjustment of feeder lines and stubs for impedance matching.

The dipper can also be readily adapted to measure the values of unknown capacitors and inductors and of circuit "Q," which is the ratio of reactance to resistance. It provides students of electronics many hours of interesting and instructive "lab" practice on a small scale.

To check a capacitor, it is necessary to have inductors of known value with which it can be combined to form a simple tuned circuit. As the coils furnished with grid-dip meters (even the kit jobs) are factory-made, they can conveniently serve as standards. For example, the plug-in units of the "Knight-Kit" dipper have the following characteristics:

COIL COLOR	FREQ. RANGE (mc.)	INDUC. (μhy.)	DIST. CAP. ($\mu\mu$f.)
Red	1.5-3.5	200	6.5
Violet	3.4-8.5	40	5
Blue	8.2-20	6.7	4.5
Orange	19-45	1.3	4

With these coils, it is possible to measure values from 40 to about 7000 $\mu\mu$f. Values below 50 $\mu\mu$f. can be determined if a known capacitor of 50 to 100 $\mu\mu$f. is available. The circuit arrangement is very simple. Connect the unknown capacitor to the prongs of one of the coils, selected at random, by means of alligator clips and short leads. Leave the assembly loose on the table. Plug one of the other coils into the dipper, move it near the first coil, and tune around for a dip. If it doesn't appear readily, try another of the coils. A minute of experimentation will give you the right combination. Note the frequency indicated by the dipper and then solve the formula for C:

$$F = 1/(2\pi\sqrt{LC})$$

where: F = frequency in cycles; L = inductance in henrys; and C = capacitance in farads.

For the most accurate final figure, subtract the distributed capacitance of the coil connected to the capacitor under test.

Low values of capacitance between 10 and 50 $\mu\mu$f. fall in a range that cannot be checked directly without requiring duplicate coils. However, a simple trick is to parallel the unknown capacitor by one between 50 and 100 $\mu\mu$f., getting a frequency reading, solving the formula for C, and then subtracting the value of the extra capacitor from that of the one undergoing measurement. This is quite legitimate, since capacitors in parallel merely add up, irrespective of their individual values.

In practical work, it is usually much less important to know values of inductance than of capacitance. However, the measurement can be made in exactly the same manner, using capacitors of known value across the unknown inductor. This time solve the formula for L.

It is sometimes interesting to know the "Q" of a circuit or to compare the "Q's" of several circuits. If a v.t.v.m. is available, this is easily done. The dipper is used as a signal generator. Connect the r.f. probe of the v.t.v.m. across the circuit, couple the dipper to the latter, tune the dipper for maximum reading on the v.t.v.m. and note this frequency, f_o. Retune to the right and to the left to find frequencies f_1 and f_2 for which the v.t.v.m. readings drop to 70.7 percent of the value for f_o. Keep the coupling constant. Then calculate "Q" from the formula:

$$"Q" = f_o/(f_1 - f_2)$$

The grid-dipper is not primarily a service instrument and, being without audio modulation, it is not really suitable for receiver adjustment if this process is normally carried on with the set's loudspeaker as the indicating device. However, it is a generator of known r.f. signals and is therefore of some value in the absence of better facilities. With the v.t.v.m. connected to the a.v.c. line of the receiver, at least the r.f. and i.f. sections can be checked.

There are many other applications for this highly useful and inexpensive piece of test equipment. Details on many of these are usually covered in the instruction manuals of the grid-dipper, in magazine articles, or in books. For versatility and simplicity, the grid-dip meter is hard to beat. [30]

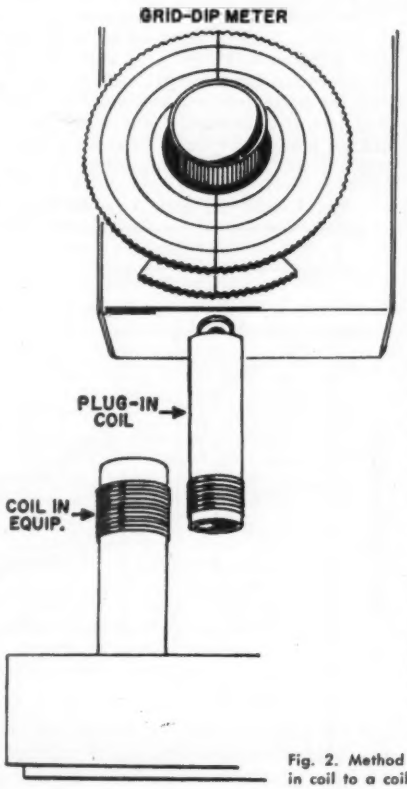


Fig. 2. Method of coupling the dipper's plug-in coil to a coil used in a piece of equipment.

Vertical-Output Test Transformer

By **OLIVER WILLIAMS**
Chicago Standard Transformer Corp.

This multi-tapped, "universal" replacement can also be used as a troubleshooting instrument.

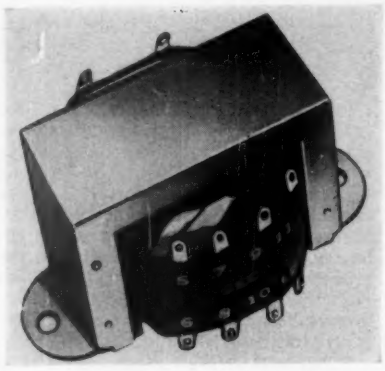


Fig. 1. The versatile VO-109 has two primaries, eight terminals on its secondary.

WHEN IS a transformer more than a transformer? When it's a piece of test equipment, in addition. This is the case with an unusual multi-ratio, vertical-output transformer, the *Stancor* VO-109. As shown in Fig. 1, it does not look drastically different from other vertical-output units, except that it does seem to have an exceptional number of terminals, which are numbered.

This multiple-tapped transformer was initially conceived as a versatile replacement component. Although it costs somewhat more than conventional components of this type, it can assist the service dealer faced with the problem of carrying in stock a large number of different units. However, it has turned out to be a useful time saver in checking vertical-deflection circuits.

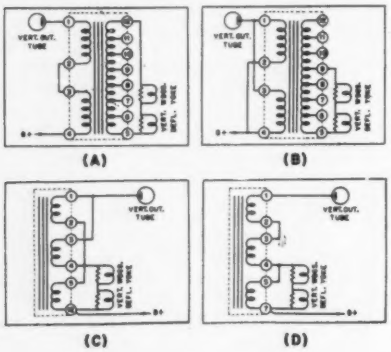


Fig. 2. Four of many possibilities show series (A,D) vs parallel primaries and autotransformer (C,D) vs isolation use.

The added capabilities of the VO-109 derive from the fact that it can provide any one of 112 different stepdown turns ratios over a wide range. Half of these ratios are available when it is used as an isolation-type transformer and the other half when it is used as an autotransformer. As an isolation unit, it provides ratios from 5:1 to 360:1. As an autoformer, the range is from 6:1 to 361:1. The unit is designed so that there are very small gradations in turns ratio in the most frequently used ranges.

Part of the versatility comes from the fact that there are eight taps on the transformer's secondary. In addition, the VO-109 has two primaries, which may be connected either in series or in parallel for any combination of secondary connections. Supplied with the transformer is a data sheet that lists all possible turns ratios as an isolation unit together with the secondary terminals to be used for each and the manner in which the primaries are to be connected. When an autoformer is called for, the same list of 56 possibilities is used except that each ratio is increased by one (*e.g.*, 10:1 becomes 11:1) and an indicated primary-to-secondary connection, different in each case, is made.

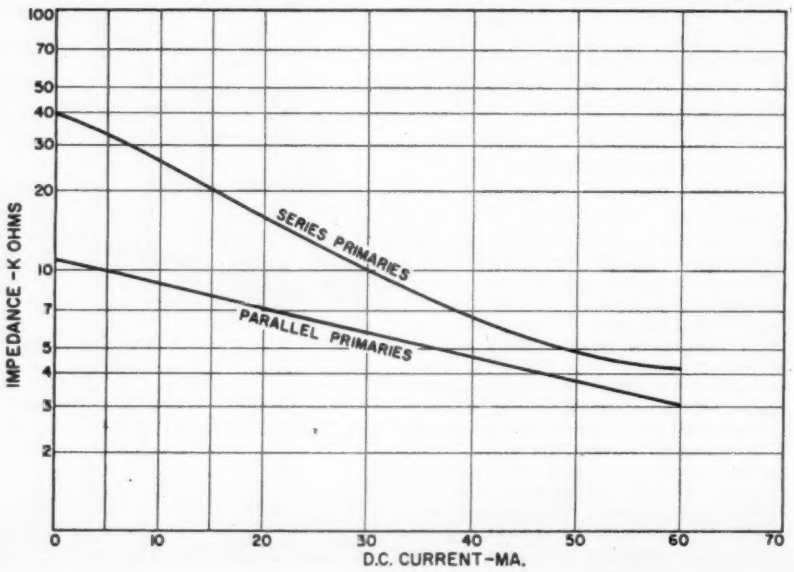
Fig. 2 indicates just four of the many possibilities. With the primaries in series and the full secondary in use (Fig. 2A), an isolation transformer with a 10:1 turns ratio is obtained. Using the same secondary terminals but connecting the primaries in parallel would provide a 5:1 ratio. A typical parallel-primaries connection with isolation is shown in Fig. 2B, where the secondary is tapped to provide a 9:1 ratio. Two autoformer connections are also shown. In Fig. 2C, the primaries are in parallel and the secondary is tapped for a 6:1 ratio. A 45:1 autoformer with series primaries is shown in Fig. 2D. It is obviously not a simple task to work out the individual connections for each requirement. However, the wise technician who keeps the data sheet handy already has this done for him.

As to test applications, consider the technician working on a vertical-deflection circuit with a hard-to-find fault. The transformer may be the villain but he cannot be sure short of a substitution check. A close enough replacement is not handy, and comparison against a mismatched unit can produce misleading indications. Shall he buy an exact replacement he may not need, particularly if it is an odd type he may never use later, or shall he continue to waste bench time? With this "universal" replacement in the shop, he is almost certain to be able to make up a substitute.

In addition to providing the proper turns ratio, a replacement transformer must also present a satisfactory impedance to the vertical amplifier to which it is connected. In practice, however, obtaining this match is not as difficult as might appear. Nevertheless, to facilitate a check for impedance, the graph of Fig. 3 is also included with the transformer data. Direct current in the primary is measured with the transformer in the circuit. Once this is known, the primary impedance of the

(*Continued on page* 90)

Fig. 3. With d.c. primary current known, impedance may be read from this graph.



Servicing Phase-Modulated Transmitters

By
BOB ELDRIDGE

A practical guide to the general principles of operation of a fairly common but imperfectly understood circuit found in two-way mobile radio equipment.

THE RADIO-TV technician extending his field of interest into two-way mobile radio servicing will find that many things are similar to those encountered in his previous experience, but a few circuits and techniques are rather different. Transmitters, in general, fall into the latter category, but fortunately most of the circuits and adjustments are quite straightforward and easy to grasp, especially for the man who has spent some time in ham radio.

There is, however, one part of the transmitter not easily understood without special study. This is the phase modulator and the speech amplifier which feeds it. The purpose of this article is to give the practical technician a guide to the general principles of operation of this portion of the set, and the methods of servicing it.

It is not proposed to delve too deeply into the theory of phase modulation, except where it is necessary for the understanding and repair of the transmitter. The FCC requires that any person making adjustments to transmitting sets must be technically qualified and must hold at least a Second-Class Radiotelephone Operator's License, to obtain which an applicant must demonstrate that he is familiar with the techniques of transmitter adjustment, particularly with regard to the bandwidth and carrier frequency of the emitted signal.

Why Is FM So Useful?

On frequencies above 30 mc., most communications transmitters use some form of frequency modulation, because of the better signal-to-noise ratio this mode makes possible. Static and electrical noise take the form of amplitude modulation, and amplitude-limiter circuits have been developed for FM receivers which very effectively strip undesired interference from incoming carriers. Similar devices cannot be used in AM reception, because they would strip off the desired voice modulation too. In AM we are able to use only short-time-constant peak noise limiters. This type is not very effective on weak signals in the presence of a generally high noise level.

Modulators in Two-Way FM

Of several possible methods for producing frequency modulation, two-way mobile transmitters normally use one that involves a reactance-tube *phase modulator*. Although this type produces a rather small frequency deviation or modulation swing, it can be employed with a very stable, crystal-controlled oscillator, while quite a large deviation may still be obtained after initial modulation.

Phase modulation differs from more conventional frequency modulation in one important characteristic, which it is well to remember: in direct FM, the amount of deviation from the carrier frequency depends solely on the *amplitude* of the modulating signal. In PM, the amount of deviation depends on the *frequency* as well as the amplitude of the modulating signal. In fact, the extent of deviation is the product of the amplitude and the frequency of the modulating signals.

Why this is so is not important here, but it is essential to grasp this fact concerning phase modulation if you want to understand fully the speech-amplifier circuitry of the PM transmitter. Better go back and read the statement again.

The effect of this characteristic is such that, where two modulating signals of the same amplitude differ in

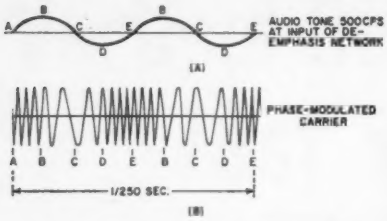


Fig. 1. Frequency changes produced in a carrier (B) phase-modulated by audio (A), shown here as a 500-cps sine wave.

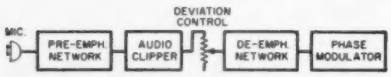


Fig. 2. Block diagram of a typical speech amplifier-modulator system. Refer to text.

frequency, the one higher in frequency will produce more deviation during modulation. Another way of expressing this fact is to say that PM automatically provides high-frequency pre-emphasis in transmission. This is desirable since, when combined with complementary de-emphasis at the receiving end, it provides a better signal-to-noise ratio. It is not necessary to elaborate this fact as it has been covered many times in connection with commercial FM broadcasting and reception and also with respect to frequency compensation in long-playing records.

Appearance of PM Waveform

Before we go any further, we had better take a brief look at the relationship between the transmitted, phase-modulated waveform and the audio waveform which controls it. Fig. 1 shows the changes which occur when audio tone is fed into the de-emphasis network preceding the grid of a phase modulator stage:

(1) From *A* to *B*, as the audio wave increases in amplitude in a positive direction, the transmitted carrier decreases in frequency. At *B*, the successive cycles of the carrier are farther apart, so there are fewer per second at that point. We can also say that the *phase* of each successive cycle has been retarded in relation to that of the preceding cycle.

(2) From *B* to *C*, as the audio wave decreases in amplitude, the frequency of the carrier continues to decrease, until at *C*, it reaches the lowest carrier frequency.

(3) From *C* to *D*, as the audio wave increases in a negative direction, the transmitted carrier increases in frequency, but does not reach maximum.

(4) From *D* to *E*, the audio wave returns to zero, but the carrier increases to maximum frequency at *E*. Frequency is equal to that of the unmodulated carrier at *B* and *D*. (In direct FM, exact carrier frequency occurs at *A*, *C*, and *E*, shifted 90° from PM.)

This figure shows that the *rate of change* of the amplitude of the modulating audio signal causes a corresponding *rate of change* of the transmitted frequency. The *amount* of frequency change is the factor which is determined by the *voltage and the frequency* of the modulating audio at any given instant.

Maintaining Bandwidth

It is very important, for the sake of good communications, that the frequency deviation of the transmitted signal be maintained close to a specified amount. The entire bandwidth that a transmission may occupy is limited by law to prevent excessive modulation deviation from swinging as far as the next adjacent channel assigned on either side of the carrier.

If excessive deviation is produced, it

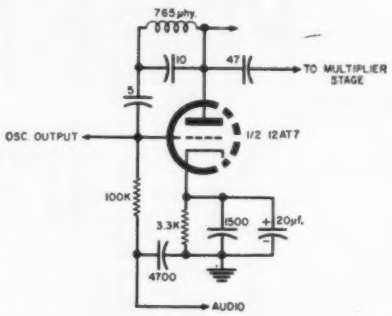


Fig. 3. A typical phase modulator which is to be found in many commercial two-way sets.

can interfere with the adjacent channels. This bandwidth, to which the receiver i.f. bandwidth is matched, must accommodate the maximum frequency deviation produced by modulation as well as significant sidebands. Theoretically, an FM signal has an infinite number of sidebands, but we disregard the almost undiscernible, higher ones.

When the modulated signal occupies this full bandwidth, we have a condition of "100 per-cent modulation," insofar as this term can be applied to FM. Aside from the limitation imposed by the FCC, there is another good reason for avoiding over-modulation. Since that part of the signal which deviates excessively will not be accepted by the i.f. bandwidth of the receiver, the audio output will be distorted and intelligibility will suffer. Except for some receivers (using "audio-compensated" squelch circuits), the distortion products will cause intermittent squelch action on loud speech passages and intelligibility deteriorates even more.

On the other hand, when there is considerable under-modulation (deviation well under the allowed bandwidth), voice quality will be good, but voice level will be low. The signal-to-noise ratio will thus be impaired, unless the received carrier happens to be very strong.

From these facts, it is obvious that, although modulation should not exceed the prescribed level, it should be maintained as close to that level as possible. To achieve these conditions, the transmitter uses an audio clipper (or audio limiter).

Function of the Clipper

The purpose of the audio limiter stage is to act as an amplifier with a particular, pre-set maximum output, which will not be exceeded no matter how strong a voice signal is fed to it from the microphone. Now the most "dangerous" frequencies (those most likely to result in over-deviation) are the higher ones, in the region of 2000 to 3500 cps, because they will be boosted or pre-emphasized by the modulator. If we can prevent the modulator from "swinging" the carrier too much on these frequencies, the lower ones are not likely to cause trouble. So, in order to limit the higher voice frequencies selectively, we pre-emphasize them at the input to the clipper. Fig. 2 is the block diagram of a typical speech amplifier-modulator system.

Since we have already noted that the phase modulator itself will pre-emphasize the higher frequencies, it would seem that we are doing the same thing twice and that one of these times it is unnecessary. We had better recapitulate.

The phase modulator will give a desired, automatic high-frequency pre-emphasis—if we feed "flat" audio signals to it. However, we wish to impose a limit on the higher-frequency audio signals before they reach the modulator. To provide this selective limiting, we introduce pre-emphasis before the clipper. Since this pre-emphasized audio must be "flat" before it is fed to the modulator, we flatten it out with a de-emphasis network following the clipper (Fig. 2) that complements the action of the pre-emphasis network before the clipper. Except that the higher frequencies have been prevented from exceeding a certain maximum amplitude, the flat output of the de-emphasis network is fed to the modulator, where it receives the desired pre-emphasis. Since the earlier, selective limiting matches the boost provided by the modulator, the possible deviation that can be produced by any modulating frequency is limited to the same maximum.

The Modulator Stage

The phase modulator performs a function which is a little more difficult to understand. It shifts the instantaneous phase of the carrier above and below its normal phase, thus effectively changing its frequency, in sympathy with the modulation. See Fig. 3.

For brevity, we will oversimplify action of the reactance modulator, as it is also called. Grid input from a crystal oscillator passes to the plate by two separate paths: (1) through the electron stream within the tube, a resistive path, and also (2) *via* the grid-plate capacitance of the tube, and parallel, external capacitance. This path is reactive.

When audio is applied to the modulator grid, the operating point of this tube is varied at an audio rate, and the amount of r.f. energy conveyed along the resistive path varies in sympathy. The r.f. going by the reactive route is constant, but is 90 degrees or so out-of-phase with the original oscillator out-

put. The phase of the r.f. arriving at the plate at any instant is therefore the resultant of the two separate arrivals, and varies constantly at an audio rate of change.

The amount of frequency deviation (phase shift) is quite small, especially when we use a stable crystal oscillator as the source of r.f. energy. It is because of this fact that we place the modulator right "up front" after the oscillator. If we then follow up with a chain of multipliers, we can achieve useful deviation at the desired output frequency. For example, a 12-mc. oscillator with a deviation of plus or minus 2 kc., followed by two doublers and a tripler (12 times multiplication), will result in an output carrier wave of 144 mc. with plus and minus 24 kc. deviation.

Practical Clippers

Before we leave the theoretical aspect of modulation, let's take a look at a typical audio peak limiter circuit, shown in Fig. 4. The input from a high-impedance microphone is amplified by the two-stage audio amplifier, V_{10a}. The coupling components between the first and second stages, C_{17d} and R_{17d} are of suitable values to act as a pre-emphasis circuit.

The audio, greatly amplified, is then passed on to the twin-stage voltage limiter, V_{10b}, which operates as a limiter by the production of self bias at the grids. The clipped audio is then passed on to deviation (modulation) control R_{18c}, and then through a de-emphasis circuit, the voltage developed across C_{18d} being applied to the grid of the phase modulator.

Just to remind you that life for a two-way radio technician is no easier than it is for any other working Joe, Fig. 5 shows another type of clipper, used in the *RCA* "Carfone" series. Right at the beginning (mike input to V_7) there are some rather unusual component values. $2C_{25}$, $2R_{26}$, and $2C_{24}$, form the pre-emphasis network, and the values of $2C_{27}$ and $2R_{29}$, the coupling network to the next stage, are chosen to assist the rising treble characteristic.

The second section of V_7 and the first section of V_8 comprise a cathode-coupled double peak limiter. High positive peaks of audio cause heavy conduction through V_{7b}, producing a high positive voltage at the cathode. This cathode, being directly connected to the cathode of V_{8a}, cuts off V_{8a}. High negative peaks of audio cause V_7 itself to cut off momentarily. Thus, between the two of them, these triodes manage a symmetrical clipping of the audio wave. The output to deviation (Mod. Gain) control $2R_{38}$ is from the junction of $2R_{33}$ and $2C_{29}$, which form a de-emphasis network. (Note that $2C_{29}$, .047 μf., is large for a plate bypass.) The second half of V_8 is a conventional triode amplifier.

Measuring Deviation

Before moving on to the practical servicing of transmitters, some discussion of deviation measurement may be of interest to those not yet familiar with the techniques. Of the many peak deviation meters on the market the *Lampkin* 205A, a widely used one, will serve as a typical example. A discussion of the principle of operation is outside the scope of this article, but a brief description of the procedure in making a routine check will illustrate how straightforward the operation is.

Transmitters should be serviced connected to a dummy load in place of an antenna, the most convenient form of which is an indicating wattmeter, with one or more ranges directly calibrated in watts. The dummy load radiates enough r.f. energy to activate the *Lampkin* anywhere in the repair shop, when the flexible whip antenna provided as standard equipment with this deviation meter is used. Since details will differ from one deviation-measuring instrument to another, just a general idea of method will be given.

First the transmitter being checked is turned on and set to produce an unmodulated carrier. The deviation meter is set to read unmodulated, radiated signal, and tuned for maximum indication on the transmitted frequency.

The deviation meter can be set to read positive and negative deviation separately (upper and lower sidebands). During the loud "aaaaah" it should be switched alternately to read positive and negative to make certain that modulation around the center frequency is uniform.

The latter check is important because, due to a change in the operating conditions of the modulator tube (often due to deterioration of the tube itself), lopsided carrier modulation may result. If you adjust the transmitter while observing only one side of the carrier, one of two undesirable things will result if the sidebands are not symmetrical.

Let us assume the upper sideband is twice as wide as the lower, as in Fig. 6. If the deviation control is set to give 12 kc. whilst looking at the upper side, then the lower side will be only 6 kc. wide. If, on the other hand, the control is set when looking at the lower side, then the upper side will be 24 kc., and the total bandwidth 36 kc. FCC regulations set down the maximum permitted peak deviation above or below the assigned frequency, *not* the average of the upper and lower sidebands.

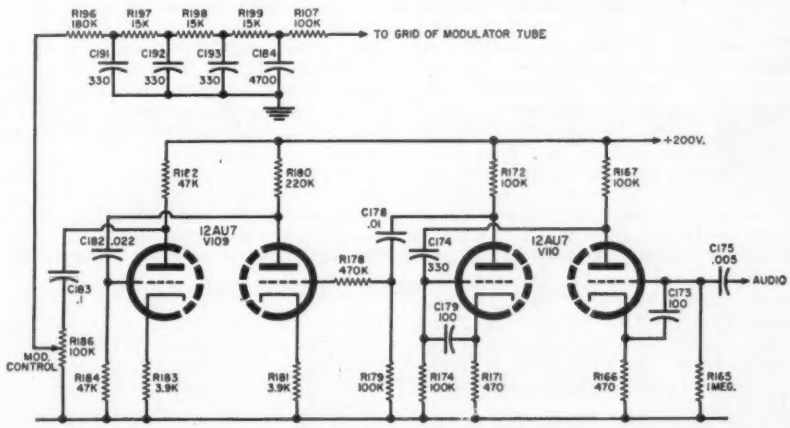


Fig. 4. An audio peak-limiter circuit of the type found in two-way mobile equipment.

(To make certain that the right transmitter is being picked up, the latter should be switched on and off. Note to make certain that the needle on the deviation meter falls back to zero each time the transmitter is turned off.)

The deviation meter is then set up so that, when it is exactly tuned to the unmodulated carrier, it indicates zero. The transmitter is then set up so that it can produce modulation. Any reading now obtained on the meter represents noise on the carrier. Speaking into the microphone will cause the meter needle to fluctuate, producing a direct reading in kc. of the carrier deviation that results.

A sustained, loud "aaaaah" should run the clipper well into limiting condition. The transmitter's deviation control can be set, while this sound is being made, to produce the maximum, desired transmission bandwidth. This is the sound that has made more than one radio-communications shop sound like a sheep corral on occasion!

Sometimes two or three new tubes have to be tried before symmetrical modulation is obtained, even though the circuit constants are in order. In a difficult case, take a look at the audio output from the deviation control, in case an irregularity has developed giving an unbalanced audio waveform from the speech amplifier and clipper circuit. This is not very common, but it does sometimes happen.

Servicing Audio Clippers

An audio limiter and amplifier circuit, like the one shown in Fig. 5, will generally be checked only when the reason for a complete absence of modulation must be traced. However, it should be noted that, without observing the waveform developed across control $2R_{38}$ at various levels of input to the microphone terminals, it is hard to tell whether the limiters are working properly or not. First check the 12AX7 tubes

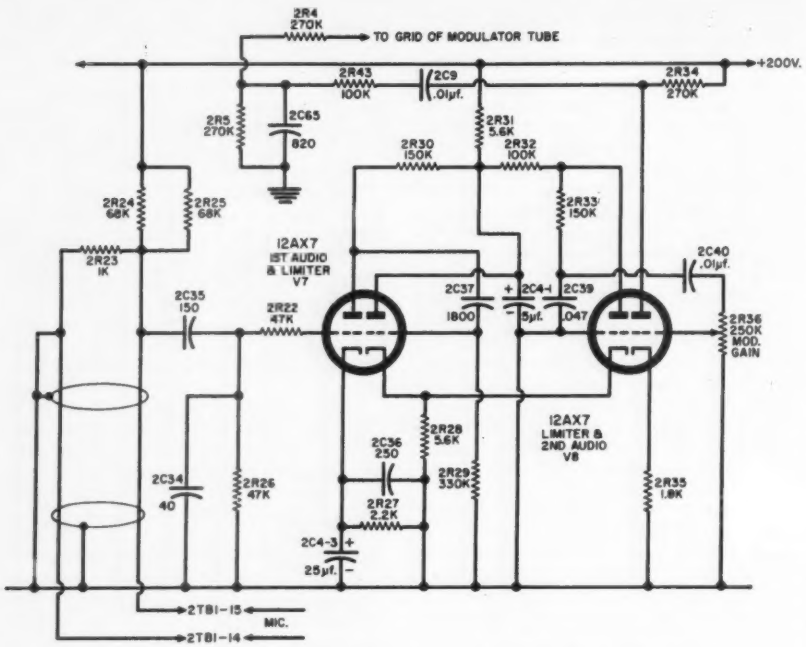


Fig. 5. Another type of clipper, this one as used in RCA's "Carfone" series.

for emission or mutual conductance. Since they work fairly hard, they may need more frequent replacement than most other tubes in the set.

Then, with the transmitter working into a dummy load, set up a peak deviation meter while modulating the transmitter with a volt or so of audio at the microphone terminals. Don't forget that the set shown in Fig. 5, like others that will be encountered, is designed to work with a carbon or controlled-reluctance microphone, so d.c. voltage appears across the microphone terminals (*2TB1-14* and *2TB1-15*, in this case). Make sure your audio generator is equipped with isolating capacitors to block this d.c.

Now increase the audio input, while watching the deviation: little or no increase in deviation should occur. Then reduce the input: below about .6 volt the deviation should begin to fall off in proportion to the decrease in input. The exact point at which limiting occurs is not very important but, if it is more than a volt or so, a fault should be suspected (and usually this means a bad 12AX7).

If a scope is handy, it can be hooked across $2R_{36}$: flattening of the waveform should be seen when the input voltage exceeds about .6 volt. It is useful for future reference to make a note of the r.m.s. voltage appearing across $2R_{36}$ with .25-volt input (be sure to make a note of the frequency, or better than that, standardize at 1000 cps); and then, with $2R_{36}$ at maximum setting, measure the r.m.s. voltage at the modulator grid. Momentarily remove the crystal while making the grid measurement. When another, similar set is suspect, it is very handy to have a note of the stage gain which can be expected in a normal unit.

Complete absence of modulation calls for a check at *2TB1-14* and *-15* with a voltmeter. Under normal conditions, there should be about 1 volt across here when a carbon microphone is in use, and this should vary with speech, indicating that the resistance of the microphone capsule is changing as the diaphragm moves. Absence of any voltage indicates either a short-circuit across the mike (or the wires leading to it) or a break between *2TB1-15* and the 200-volt line.

Breaks sometimes occur at the rear of the connectors used, or at the control-head terminal board. This shows up as a higher-than-normal voltage across *2TB1-14* and *-15*: with no parallel path through the mike, the voltage divider from the "B+" line to ground has a ratio of 34:1, and simple application of Ohm's Law shows that there should be about 6 volts appearing across the 1000-ohm resistor, $2R_{22}$ in Fig. 5.

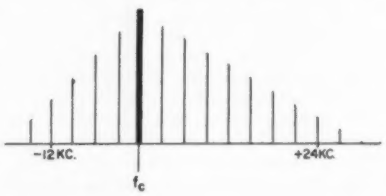
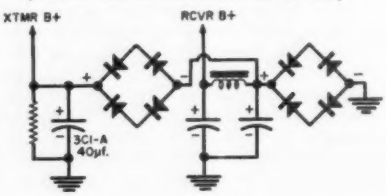


Fig. 6. "Lopsided" carrier modulation with the upper sideband twice the width of lower.

Fig. 7. Power supply circuit of the RCA "Carfone." One type of filter defect may produce hum in transmitter section only.



The terminals at the rear of the *Cannon* connectors used must be handled with great care. The wire hooks bend easily and are very close to each other; each wire is the center plate of a feed-through capacitor which has very fragile insulation. If you apply too much heat to these terminals, another solder joint inside the connector shell may melt, and that means real trouble, for it is almost impossible to make repairs inside the connector.

Noise on the Carrier

There are two main types of noise that will be encountered on the carrier: hash and hum (usually 130 cps). Hash in the transmission will usually be present in the associated receiver too, and is rather difficult to track down, particularly since it is often due to the cumulative effect of a number of minor faults. Key points that are likely to be involved include:

(1) *The vibrator:* Naturally this is the first suspect, and trial by substitution is the only practical method. Also examine very carefully the bonding to the chassis of the ground connections at the vibrator socket, and make sure there is good electrical contact between the shell of the socket and the chassis. The vibrator is not the only point at which good contact is important.

(2) *Bonding:* Make sure that the separate chassis of the communications set (usually three) are tightly bolted together. Do not just tighten up all the bolts that you can *see*—check for *missing* ones too. Due to vibration, such hardware can come loose and fall out after a long period of operation without service. Other connections also tend to be broken by mechanical stress. Check machine screws, such as those that hold on bottom or back plates, to make sure that they are present and tight. Soldered connections, like those that secure battery leads to connectors, should also be investigated. Such connections can give quite a bit of trouble in units that are bounced about a lot: the solid copper wire used in such leads is rigid and may not yield easily to mechanical stress.

(3) *Bypass capacitors:* Check those on the heater line. A defective one may contribute to hash.

Hum is most often due to defective filtering in the power supply. This may or may not be evident in both the transmitter and receiver. Take the power-supply arrangement shown in Fig. 7, which is used in the *RCA* "Carfone" series. To obtain higher "B+" for the transmitter, an additional rectifier system is stacked with the one used for the receiver. Thus a defect in capacitor $3C_{1A}$ will affect only the transmitter's "B+" supply.

Another cause of hum pick-up is faulty grounding of the shield on the coaxial cable in the microphone circuit. This should be grounded *only* at the points shown in the manufacturer's schematics and service diagrams. Indiscriminate grounding may do more harm than good, resulting in hum loops. [30]

Zener Diode Testing

By HAROLD REED

Suitable testing methods and a simple bench test circuit used for checking these special silicon regulator diodes.

SILICON zener diodes, also referred to as avalanche diodes, are finding new applications in electronic circuitry. This, together with their use in conventional ways, is resulting in a continually greater usage of this circuit element.

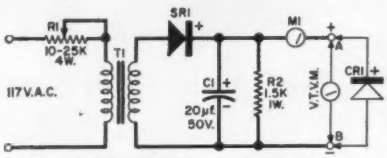
The service technician and experimenter, therefore, should become acquainted with suitable testing methods and may set up simple bench test circuits for applying recommended test procedures.

Simple ohmmeter testing of a good diode will indicate low diode resistance when the positive ohmmeter lead is connected to the diode anode and the negative lead to its cathode. Likewise, when the ohmmeter connections to the diode are reversed, a high resistance reading will result. Ohmmeter testing, however, does not provide information concerning the dynamic operating characteristics of the zener diode.

To check the zener voltage, E_z, the simple circuit of Fig. 1 was set up by the author. With variable power control, R_1, turned all the way down, the diode to be checked, CR_1, is connected to test terminals "A" and "B." Note that the cathode of the diode connects to the positive terminal. Thus, the voltage is applied in the reverse direction, which is correct for obtaining the zener, or junction breakdown, effect. A d.c. vacuum-tube voltmeter is also connected to these test terminals and its range switch set to read the zener voltage expected. R_1 is then brought up slowly. The v.t.v.m. will immediately indicate a rising voltage but the current meter, M_1, will show little or no current flow. As the voltage approaches the nominal zener voltage of the diode, it will avalanche, if working properly, and the current will increase rapidly. The voltage, however, will remain practically unchanged after E_z is reached.

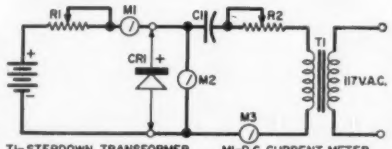
As an example, suppose a MZ10T10 diode is connected to the test terminals of the circuit of Fig. 1. This unit has a zener voltage range of 9.1 to 11 volts with a nominal E_z of 10 volts. Its maximum d.c. current is 75 ma. Now, turning R_1 up slowly will cause a rising voltage indication to appear on the voltmeter. When this voltage nears 9.1 volts the current shown by meter M_1 will rise quickly and, at this voltage, it will reach about 15 ma. This test current value is 20 per-cent of the maximum (75 ma.) d.c. zener current for this diode. If we now continue to turn up R_1, the current will continue to increase but the voltage will remain, nominally, at about 10 volts.

In the test circuit of Fig. 1, diode SR_1 will handle up to 750 ma. and the *Stancor* transformer secondary has a capacity of 1 ampere at 25 volts, allowing zeners up to 10 watts to be tested.



TI-TRANSFORMER, SEC. 25.2V., 1 AMP., STANCOR P-6469
SRI-SILICON DIODE, 750MA., INTERNATIONAL RECTIFIER CORP. SD-91A
MI-CURRENT METER, D.C.

Fig. 1. To check the junction breakdown, or zener voltage, this simple circuit may be used. SR_1 rectifies the a.c. to supply a d.c. test current. The zener diode CR_1 is connected across circuit as shown.



TI-STEPDOWN TRANSFORMER
M2-A.C.V.T.V.M.
MI-D.C. CURRENT METER
M3-A.C. " "

Fig. 2. Circuit used to check impedance of zener diode CR_1. D.c. voltage source, shown as battery, is actually power supply.

Of its many applications, the zener diode is found most frequently in voltage and current regulator circuits. Because of this, a most important test is to determine the zener diode impedance, Z_z. This a.c. impedance is directly related to the diode's regulating ability. It behaves similarly to a capacitor, that is, as its reactance decreases so does the change in potential across its terminals. The impedance value varies with junction current and the diode ratings.

Take, for example, the characteristics of the MZ3.9T10, a 750-milliwatt diode and the 10Z3.9T10, a 10-watt unit. Both have a nominal zener voltage of 3.9 but the dynamic impedance, Z_z of the 750-mw. diode is 14 ohms whereas the 10-watt diode impedance is only 0.84 ohm. Thus it is obvious that dynamic resistance measurements must be made under a specific set of conditions.

International Rectifier Corporation uses a test circuit similar to that shown in Fig. 2 for the production testing of diodes.

Here the d.c. test current is indicated by meter M_1 and is adjusted to 20 percent I_z, d.c. maximum of the diode being tested, by means of R_1. This, in effect, places the diode in the avalanche region. A small 60-cycle a.c. signal source, obtained through step-down transformer T_1, is superimposed on the d.c. current. This a.c. current is indicated by meter M_2 and adjusted to a value of 10 per-cent of I_z by variable resistor R_2. The a.c. voltage now appearing across the diode is indicated by the a.c. voltmeter M_2.

The dynamic impedance is then computed by using the simple Ohm's Law equation for a.c.: $Z_z = E_{zac}/I_{zac}$, where Z_z is the diode impedance in ohms, E_{zac} is the voltage indicated by meter M_2 and I_{zac} is the current reading of meter M_3.

In their data sheets, manufacturers list the diode impedance to be expected at a specified test current.

The test circuit given in Fig. 1 can be used to measure impedance by adding the a.c. circuitry as shown in Fig. 2.

Another useful test setup employs the oscilloscope. See Fig. 3. In this circuit, a 60-cycle a.c. source is applied across the diode. The a.c. voltage developed across the diode junction is applied to the horizontal input of the scope, while the current through the zener is shown on the vertical scope axis. The scope is then adjusted to obtain the characteristic "Z" pattern on the screen. This is shown in Fig. 4. Note the sharp increase in current at the zener voltage, or avalanche, point.

In making any zener diode tests, the only precaution necessary is to note the manufacturer's maximum ratings for any given diode and then take care not to exceed these ratings.

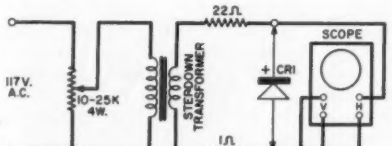
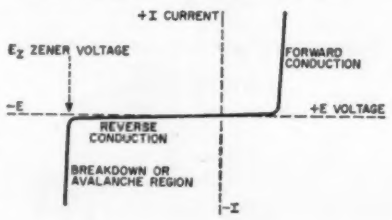


Fig. 3. Setup used for observing the zener diode's characteristics with scope.

Fig. 4. Scope trace for good zener diode.



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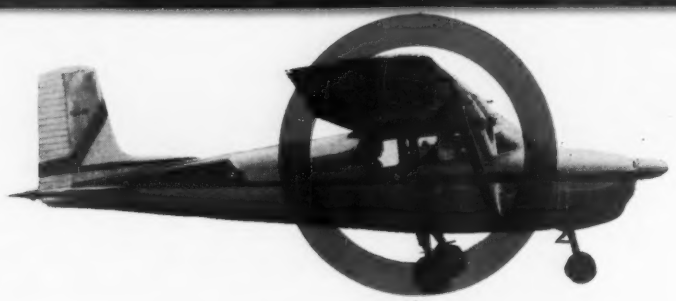
"Engineering Handbook," International Rectifier Corporation.

"Silicon Zener Diode Handbook," Semiconductor Products Division, Motorola Inc. [30]



The plane with the crew checking out the 6-meter amateur radio rig.

Go Aeronautical Mobile/It's Easy

By **DONALD A. SMITH,** W3UZN

Here is what less than a half watt of r.f. will do at 50 mc. when the ham rig is 5000 feet from the ground.

DO YOU have your doubts about the capabilities of a half to one watt of r.f. power out put at 50 mc.? Think a band opening or special band conditions are necessary to work out farther than a few miles? If so, read on!

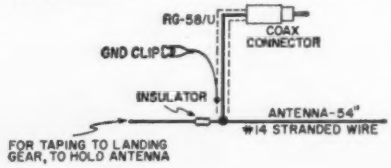
Three radio amateurs, Kent Mitchell, W3WTO; Dave Bender, W3JFQ; and the author, W3UZN, decided to find out what could be achieved. It was agreed that we would meet at one o'clock on Sunday afternoon at the Hagerstown (Md.) Airport to see what we could do with less than one watt.

Kent Mitchell holds a private pilot license and had agreed to fly the plane. The flying time, of about an hour, was to be shared which cut down the expense to less than five dollars apiece. The plane rented was a *Cessna* 172, an all-metal, 4-place aircraft. The author was to furnish the rig, which was one of the *International Crystal Company's* KB-1 transceivers for 6 meters. The power input is about 3 or 4 watts, with a resulting power output of around a watt, depending on how well the antenna loads up. In our particular case, power input to the antenna was less than that.

No physical changes, such as drilling holes or tampering with the electrical system, were permitted on the rented airplane, therefore it was necessary to set up operation in other ways. To secure power for the KB-1, which will operate on 6- or 12-volt battery or 117-volt line voltage, a power cord was made from a 6-foot length of a.c. line cord terminated in a plug which would fit into the plane's cigarette lighter. The plug was "borrowed" from a portable trouble light made for automobile lighter use. In this way the rig was connected to the plane's 12-volt battery. Later we found that these cigarette lighter plugs are readily available at auto supply stores for about 50 cents each.

The antenna used was a "trailing wire" type, cut to about a quarter wavelength. Coax (the 52-ohm RG-58/U type) was used to connect the antenna to the rig inside the plane. The shield of the antenna lead-in was grounded to the plane at the antenna, with a large battery clip. The door of the plane closed easily over the small RG-58/U cable. Details of the antenna are shown in the diagram and may be duplicated by the reader.

Diagram of the home-made antenna utilized.



The part of the antenna that looks like a paper cup (see photos) is a "Drag-Sock" made by the *Aeronautical Radio Mfg. Co.*, Mineola, N.Y. It is used on long-wire, trailing-wire antennas on airplanes. We found however, that it was not necessary on an antenna as short as the one we used on six meters. If someone wishes to use a similar device and doesn't want to invest in this commercial unit, a 6- or 8-inch piece of cloth will work as well although it would not look as neat.

That is all there was to it! The rig was put in the plane, resting on the seat, the power cord was plugged into the cigarette lighter, and the antenna taped onto the step on the landing gear (through an egg insulator), and we were in business. Total time for installation: less than five minutes!

A *Hallicrafters* SR-34, with a whip antenna, was set up outside the hangar for monitoring and communications with the plane. After installing the KB-1, it was checked out with the SR-34 and everything was found to be OK. Of course at this stage we had no way of knowing to what extent engine

noise would affect communications, but we were prepared to find out.

During checkout of the rig, it was decided that the pilot's call, W3WTO, would be used by the plane's crew with Dave, W3JFQ, doing the operating. The author was to remain on the ground and do the monitoring.

"W3UZN/3, here is W3WTO/Aeronautical Mobile calling. How copy, Don?"

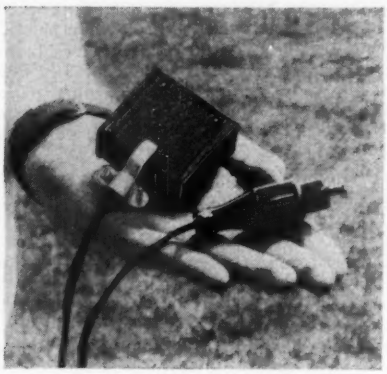
"Fine business, Dave. Signal is 5,9+. Have Kent fire up the engine and let's check on the motor noise."

There was a short pause. Then:

"W3UZN/3, W3WTO/Aeronautical Mobile. Motor noise is not at all bad. The actual noise of the motor is worse than any receiver noise. We are taxiing out to the runway, Don. Will give you a shout after Kent runs down the plane's check list. W3WTO standing by."

I watched as the plane ran up its engine across the field from me and it seemed as if the plane were chrome-plated in the bright afternoon sun. Then "she" was off down the runway and the squelch of the SR-34 was broken with:

"We're off, Don. Will give you a call when we reach 5000 feet. W3UZN/3, this is W3WTO/Aeronautical Mobile



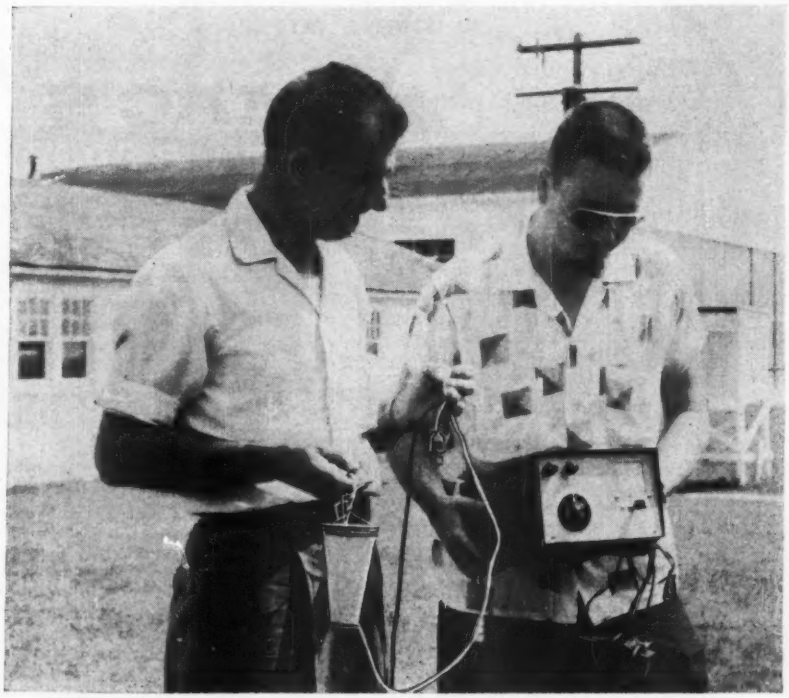
Transceiver power and cigarette-lighter plugs.

clear, and QRZ six meters for any calls."

So started our first experience operating aeronautical mobile. The plane was kept in the air for about 40 minutes. During that short period of time, over 20 different stations were worked. Locations of the stations ranged from 10 to over 100 miles away. Included in the list of stations contacted were Baltimore, Maryland; Washington, D. C.; Frostburg, Maryland, etc. Most of these stations were worked while the plane was flying in a slow circle over Gettysburg, Pa.

There were so many stations calling the plane that it was impossible to separate them at times. The best that could be done was to pick one of the stations which was more or less in the clear. Signal reports varied, but none was worse than 5,8 and the best was 30 db over S9! The stations contacted by the plane were all received at S9 or better on the KB-1.

At no time did the author lose the signals from the plane, even at distances of 50 miles or more away and using a whip antenna only two feet off the



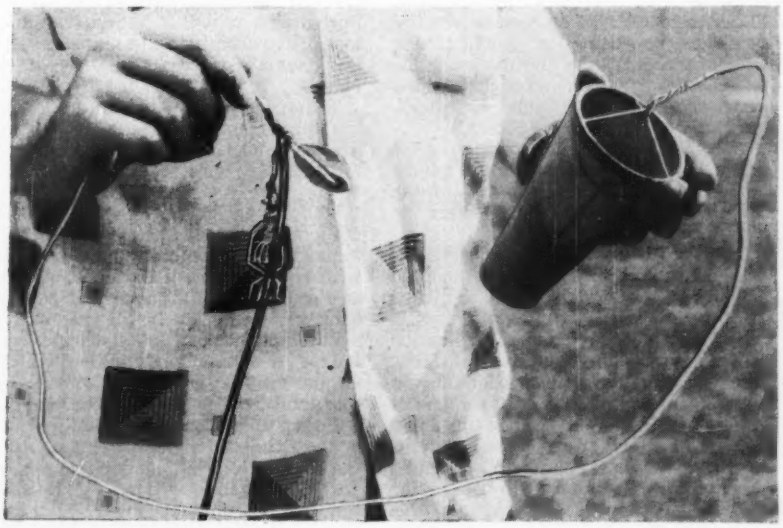
Operator of the mobile station, Dave Bender (W3JFQ) at the left, and pilot Kent Mitchell (W3WTO) are shown here holding home-brew antenna and KB-1 transceiver.

ground. Actually, signal as read on the SR-34's signal-strength meter was always over S9+. No signals which the plane received or stations which were worked were received on the ground, with the exception of W3VAM, Howard Grounds, who is located a few miles east of Hagerstown, Md.

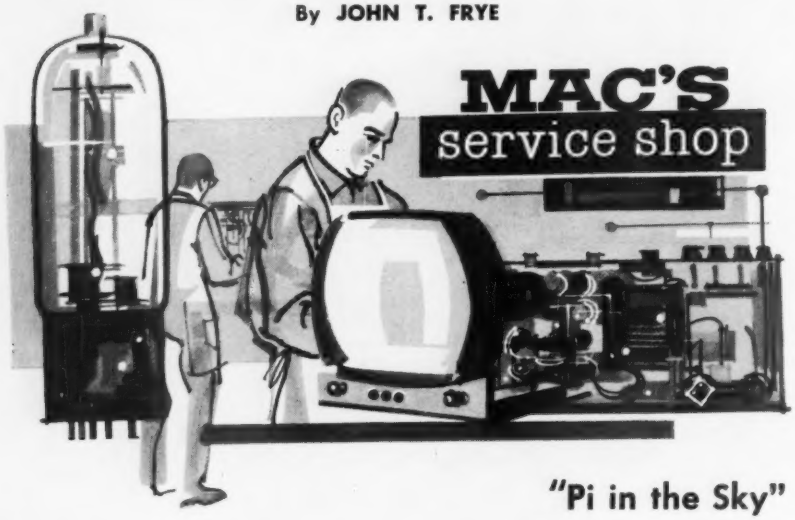
To make the experiment a complete success, a mobile station cruising along the highway in eastern Maryland was worked by the plane—aeronautical mobile to auto mobile! However, we didn't know until later that stations all over the state of Pennsylvania were calling us. We were told that we were heard in Pittsburgh and all the way across the state to Philadelphia. A pretty good haul for a half a watt! Where else we were heard, we still don't know.

So you see, small powered rigs really work out fine, when you take them up to 5000 feet or so. Power isn't nearly as important as you think when you are dealing with v.h.f. frequencies. If you check around, you will probably find that some of the fellows are pilots. If so, you're in for a surprise when you go aeronautical mobile for the first time. It isn't expensive or difficult, as we have proved and you will be working stations you would normally consider impossible with so little r.f. We will be listening for you! [30]

Close-up of the antenna. The boot at the end was later found to be unnecessary.



By JOHN T. FRYE



"Pi in the Sky"

"B-r-r-r-r, it's breezy up there on the roof!" Barney exclaimed as he came in the back door of the service shop vigorously slapping his arms around his body to restore the circulation to his numbed hands.

"What were you doing up there anyway, lover boy?" Mac, his employer, asked curiously. "When I got back from the service call, Matilda told me you muttered something about putting up a corner-reflector u.h.f. antenna and took off up the fire escape. Are we going in for u.h.f. DX-ing, or something?"

"Nope," Barney answered as he hauled a feedline through a wall insulator in the back wall. "I'm getting ready to pick up the MPATI test patterns that should be appearing on channels 72 and 76 any day now."

"And just what, may I ask, is MPATI?" Mac wanted to know.

"Midwest Program on Airborne Television Instruction," Barney explained condescendingly. "These people, with headquarters at Memorial Center, Purdue University, Lafayette, Indiana, are going to telecast educational courses recorded on video tape from a high-flying airplane over north-central Indiana. These telecasts will be received on TV sets in classrooms of participating schools throughout a circular area 150 to 200 miles in radius and encompassing parts of Illinois, Indiana, Kentucky, Michigan, Ohio, and Wisconsin."

"Hm-m-m-m; that sounds kind of familiar. Didn't the *Westinghouse* people do some experimenting with these 'stratovision' telecasts shortly after the last war?"

"Right. In 1948 *Westinghouse* demonstrated that telecasts from a modified B-29 flying at 25,000 feet could be picked up by receivers as far away as 225 miles. MPATI is a practical application of the knowledge acquired from these tests. Test pattern transmissions should start soon and will run until the end of January of next year. Mobile units will be checking the extent of the coverage. Starting January 30th and running through May 25th there will be a period of demonstration telecasts lasting three hours a day, four days a week. Then, starting in September of 1961 and continuing through May of 1962, there will be a full academic year of telecasts six hours a day and four days a week. Since different programs will be sent out on channels 72 and 76 simultaneously, that means 48 hours per week of instruction will be transmitted."

"It's going to take a lot of dough to carry out an ambitious program such as that," was Mac's Scottish observation.

"You can say that again," Barney agreed. "The cost of the program through May of 1962 will be about 7¾ million dollars. A Ford Foundation grant covers 4½ million dollars of this; contributions from private industry make up the rest."

"What kind of equipment will be used?"

"The telecasts will originate from a four-engine DC-6AB plane flying at 23,000 feet in a ten-mile circle centered roughly over Montpelier, Indiana. Ten-thousand pounds of equipment will be installed in the plane, including a 75-kilowatt auxiliary power plant located back in the unpressurized tail section. Both programs will go out from a thirty-foot TV transmitting antenna projecting downward from the belly of the plane."

"What happens to the antenna when the plane lands?" Mac asked with a grin as he pictured the plane coming in for a landing with the antenna sticking down.

"It folds back beneath the plane when not in use," Barney answered scornfully. "The cabin of the plane will be loaded with equipment. For example, starting at the front of the plane and running baok along the starboard side will be a TV transmitter, a double-rack cabinet for frequency and modulation monitors, a tape recorder, the master control console, and another tape recorder. This will take up about two-thirds the length of the DC-6AB cabin. Starting again at the front and coming back along the port side, we find a second TV transmitter, another double cabinet with auxiliary equipment, a vidicon camera for between-course announcements, a few passenger seats, and a cot in case one of the flying crew becomes ill."

"Some of that equipment is pretty delicate to be jostling around in a plane," Mac observed.

"True, and all the equipment has to be mounted firmly enough to withstand a minor crash—a wheels-up landing, for example. Safety regulations of the Federal Aviation Agency require mounting bases for equipment be able to restrain a 'forward load' of nine G's (nine times the force of gravity) on impact. That means overhead as well as floor mounts must be used on the tall cabinets and similar equipment."

"What happens to the broadcasts if the transmitters or the plane conks out?"

"Another DC-6AB, identically equipped, will be standing by at the Purdue University Airport at West Lafayette, Indiana, where the planes will be based. It would take off immediately and resume the telecasting."

"Will all the programs be on tape?"

"At the outset they will. Facilities for a ground-to-air link are available, though, and 'live' broadcasts from Purdue may be transmitted at a later date. Also experiments will be carried out with narrow-band (3 megacycle) transmission with the aim of possibly doubling the number of programs transmitted."

"What kind of courses will be transmitted?"

"Quite a variety. 40% will be at the elementary school level; 40% at high school level; and 20% at college level. I looked over the tentative schedule and found courses in French, Spanish, and Russian. There were other courses in music, art, social studies, history, and geography. Physics, biology, general science, American literature and composition, and American government and civics courses were also to be offered. What interested me most, though, were college level courses in mathematics and chemistry."

"What teachers prepare the video tapes for these courses?"

"Every effort has been made to get the very finest teachers in each subject. An intensive 'teacher talent search' was conducted by MPATI to find the most outstanding teachers in classrooms throughout the United States. Kinescoped auditions of hundreds of teacher-candidates were forwarded to viewing rooms at Purdue University where a TV Teacher Preliminary Screening Panel of experts in education and educational TV convened to sift out some 50 of the best. These 50, with the addition of some later arrivals, constitute the main pool from which a final choice of TV teachers is being made by other panels composed of eminent scholars, educational TV consultants, and other experts in relevant fields," Barney explained glibly.

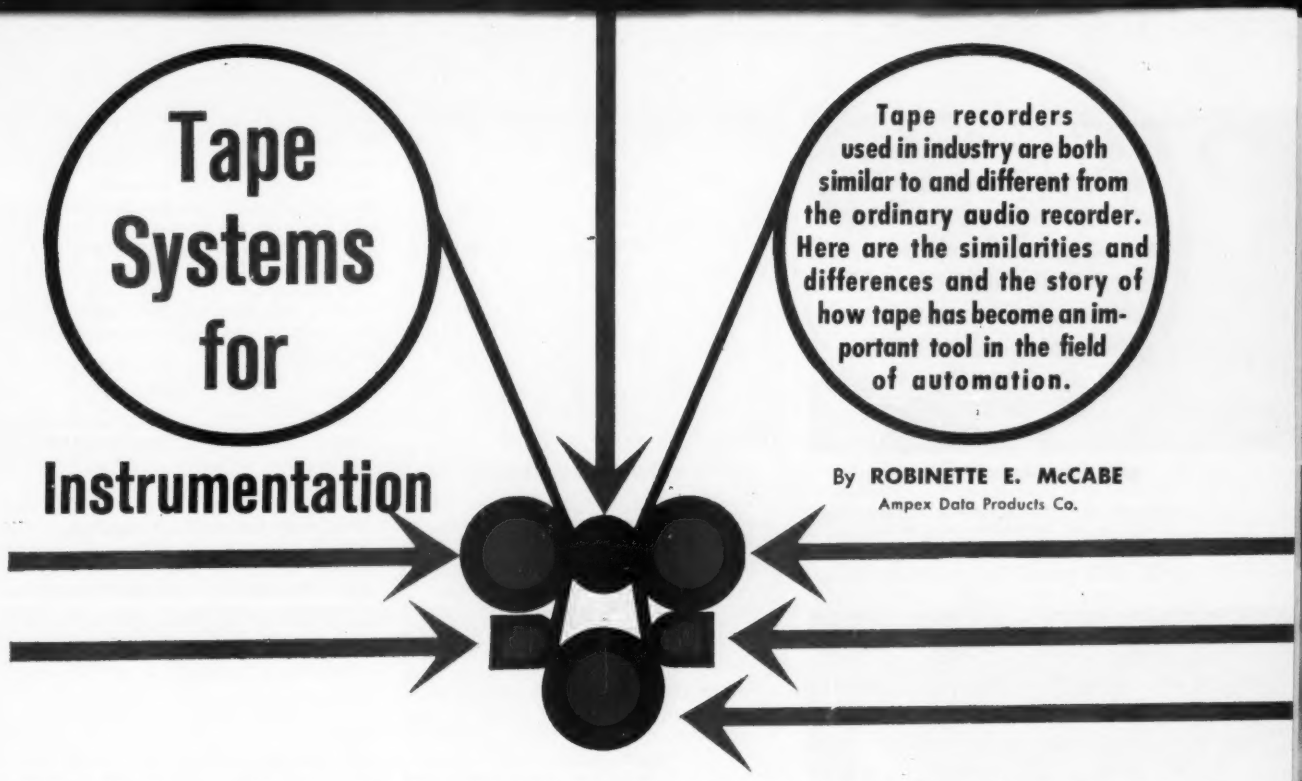
"In the area to be covered by the broadcasts," he continued, "are more than five million students in over 13,000

(*Continued on page 88*)

Tape Systems for Instrumentation

Tape recorders used in industry are both similar to and different from the ordinary audio recorder. Here are the similarities and differences and the story of how tape has become an important tool in the field of automation.

By **ROBINETTE E. McCABE**
Ampex Data Products Co.



THE ability of magnetic-tape recorders to simultaneously record a large number of different quantities which may be faithfully reproduced thousands of times has provided a new dimension for gathering, storing, and processing all types of information. Their impact is being felt in many areas, and it requires no stretch of the imagination to foresee other applications. However, with the diversification of recording requirements, it has been necessary to engineer completely new recording devices bearing less and less resemblance to their audio or high-fidelity predecessors. Unfortunately, the fundamental similarity between audio recorders and the instrumentation devices has, in many instances, resulted in insufficient attention to their differences. The result has been faulty selection and maintenance of the precision instrumentation devices—with added expense to the user. It is a situation which should be corrected.

Because there is now a distinct demarcation between speech and music recorders and instrumentation recorders, it is hoped that a comparison between the two will assist in a better understanding of the advantages and limitations of the magnetic-recording process. Wide differences are encountered between audio and instrumentation systems in all of the principal areas of a tape recorder, *i.e.*, 1. tape, 2. recording methods and electronic assemblies, 3. magnetic heads, and 4. tape transport.

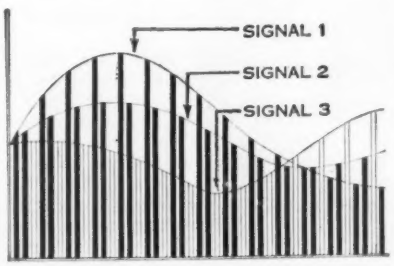
Type of Tape Involved

Two principal base-film materials are used currently in the United States for magnetic tape: cellulose acetate and Mylar (*DuPont's* polyester film). Fundamentally both are transparent films that look very much alike. They both form the substrate, or base film, that serves as the physical carrier for the magnetic coating—which is composed of a binder and the active ferro-magnetic material. However, the composition and physical properties of the two types of tape are vastly different.

Cellulose Acetate: Basic cellulose acetate, which is still used for much home recording, is a transparent, brittle material. By the addition of suitable softening agents, called plasticizers, it can be made pliable. It is made by casting dissolved and plasticized cellulose acetate on the surface of a highly-polished drum. Its finished properties depend, to a great extent, on the softening agents added and the success in achieving a homogeneous mixture. Humidities much below 30% may destroy cellulose-acetate-base tape by embrittlement. Binder degradation may begin in the range of +55°C.

Mylar: Instrumentation tapes are made of Mylar. Unlike the acetate mixture, it is a single compound; a polymer synthesized from petroleum derivatives. Its inherent flexibility makes the use of plasticizers unnecessary. Chemically, it is polyethylene terephthalate. It exhibits outstanding tensile strength, tear resistance, and flex life. Many of its physical properties are attributed to the mechanical process used in Mylar-film production in which an oriented molecular pattern is produced rather than the random molecular structure that is characteristic of most organic films. Temperature limits for safe operation generally are specified in the range of −40° to +80°C. Despite its superior physical properties, like acetate, it requires protection against sustained exposure to uncontrolled environment. Excessive dirt, temperature, and humidity can affect it adversely. Permanent shrinkage of instrumentation Mylar tapes commences at about 60°C, even though the magnetic material remains chemically stable to about 400°C (above which it reverts to non-magnetic form).

Fig. 1. PDM sampling technique. Time between samples of a given signal is utilized to sample a pair of other signals.



Recording and Electronics

There is great similarity between the direct-type record and reproduce electronics used in instrumentation systems and the electronics used with audio recorders. However, this similarity has resulted in certain misconceptions.

Direct-recording techniques, using high-frequency bias mixed with the signal to be recorded, were first used in audio tape recorders and continue to this day as the fundamental method. Sometimes called "AM-recording" (which it is not, because the signal and bias are mixed linearly), its benefits in low distortion and noise with high output are well known. One of the areas not generally understood concerns the use of pre-emphasis in the recording amplifier. Audio recorders use considerable pre-emphasis (that is, amplification) of the higher and lower frequencies. The purpose is to improve over-all record and reproduce signal-to-noise

Operator of a Videotape TV recorder at the White Sands Missile Range's Signal Missile Support Agency, New Mexico, is shown here checking out the performance of the system. The tape recorder records radar signals picked up from a missile in flight.

Control console of a large computer that employs a number of magnetic tape recorders. This electronic system handles 33,000 accounts an hour, requiring only 32 μsec. to perform each step of sorting, reading, and computing from face of bank checks.

ratio by recording music- and speech-frequency signals at approximately equal flux levels on the tape. Since music and speech generally have less energy at the high and low frequencies (compared with the middle range), this technique works very well. The reproduce electronics have built-in complementary de-emphasis and over-all flat response is maintained.

Unfortunately, instrumentation recording cannot enjoy this benefit since the frequency energy distribution of complex data signals is either unknown, flat, or too complex to use pre-emphasis to advantage. Therefore, instrumentation recording assumes a constant energy level for all frequencies and compensates for any record-head losses (due to frequency) so that recording current level is held constant.

Frequency-modulated recording, too, is common to both audio and instrumentation recorders, although the range is by no means comparable. At present, wideband FM instrumentation tape systems can provide response from 10 cycles out to 4 megacycles per second, ± 3 db. The system which provides this response uses a rotating magnetic head assembly which records information transversely on 2-inch-wide tape.

In addition to direct and FM, there are two recording techniques which have no counterpart in the audio recording field. One of these is the digital recording process which has been growing rapidly in importance as a result of the widespread application of digital computers to electronic data processing. The other is called pulse-duration-modulation recording which is particularly useful where large numbers of temperatures, pressures, positions, flow rates, and other quasi-static variables are to be recorded.

Pulse-Duration Modulation

This involves a technique in which time can be shared among a number of channels of signal information. It is called time-division multiplexing and requires an instantaneous sampling of a number of channels on a sequential basis. When we wish to record a sine wave, we normally think of a continuous recording of each instantaneous value of the wave. It is possible, however, to sample the sine wave at uniformly spaced discrete intervals; record only the instantaneous values at the time of sampling; and then reconstruct the original sine wave on playback by passing the discontinuous readings through an appropriate filter. An accurate reproduction of a sine wave can be made using as few as six samples per sine-wave cycle. This technique is, of course, equally valid for non-sinusoidal signals, provided the sampling rate is at least six times the highest significant frequency component of the non-sinusoidal wave. If a data signal is being sampled at discrete intervals, it is possible to use the time between these sampling intervals (see Fig. 1) for the purpose of sampling other data signals. This is most conveniently accomplished using a rotating commutator, wherein the outputs of a number of transducers are being sampled in sequence, once per revolution of the commutator. Fig. 2 is a simplified block diagram of a PDM recording system. As many as 85 instantaneous values can be recorded on a single track several times per second. Multiply this by the fourteen tracks available on standard analogue recorders and one can quickly see why aircraft flight testing has popularized this particular type of recording.

Digital Recording

As in the PDM system, a sampling technique is used to measure a varying signal. The sampled readings are then converted into a code consisting of a series or group of binary digits. In contrast with the familiar decimal system which employs ten digits (0 through 9), the binary system employs only two digits (0 and 1); and all numbers are expressed in terms of these two digits. The binary-coded decimal system is shown in Fig. 3.

The main reason for digital recording's popularity with computers (rather than direct, frequency-modulated, or PDM) is that digital recorders preserve the data in the language of the digital computer. The record and reproduce amplifiers for digital recording can be quite elemental, but, when an analogue recorder is to record binary-coded information, both the magnetic heads and electronics must be changed. However, modular packaging of electronics and easily replaceable heads are used on those machines designed for conversion.

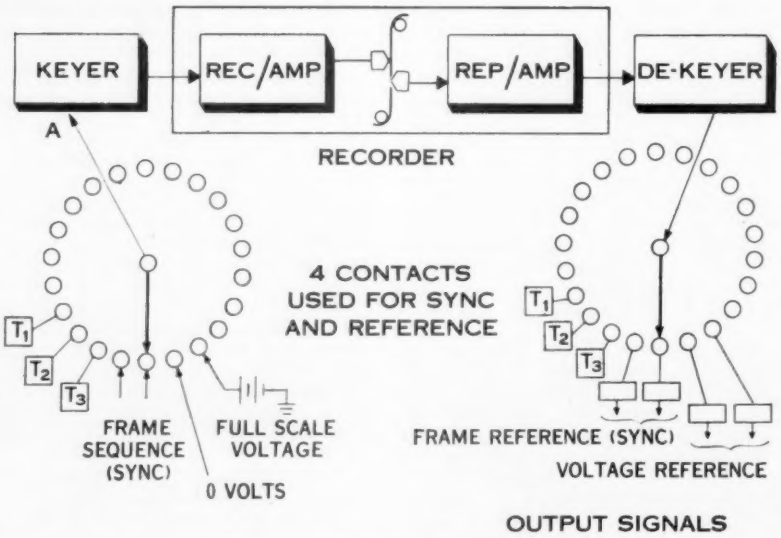


Fig. 2. Simplified block diagram of the PDM recording system discussed in text.

Magnetic Heads

Although there are high-fidelity audio recorders for stereophonic use which have multiple record heads, audio heads are generally built for only one or two simultaneously recorded tracks. In marked contrast, instrumentation heads may have up to 32 tracks. For both, however, the recording head con-

CHARACTER		BINARY CODED REPRESENTATION
0	=	0000
1	=	0001
2	=	0010
3	=	0011
4	=	0100
5	=	0101
6	=	0110
7	=	0111
8	=	1000
9	=	1001

Fig. 3. Binary-coded decimal system.

sists of a magnetic core in the form of a closed ring, having a short nonmagnetic gap in series with the magnetic path of the core.

Fig. 4 shows the construction of a typical magnetic head for an instrumentation recorder. Two identical core halves are constructed of thin laminations of a material having high-magnetic permeability, low electrical resistivity (to minimize eddy-current losses), and good physical-wear properties (for long head life). Each core is wound with an identical number of turns and assembled with non-magnetic separators for the front and back gaps. It is only the front gap which contacts the tape and actually enters into the recording process.

If optimum performance is to be obtained from any recorder, all parts of the tape drive system must be kept scrupulously clean with special attention given to the head. Heads can be cleaned with a small lintless swab moistened with a mixture of Xylene and 0.1% Aerosol. Do not use carbon tetrachloride or similar solvents to clean the heads for they may dissolve the adhesive used to laminate the heads. (For example, to assure a smooth head assembly surface finish in the order of microns, *Ampex* uses a cast epoxy head which can be seriously harmed by many commercial cleaners.)

Other parts of the tape transport can be cleaned with a swab moistened with denatured alcohol. And it is recommended that the transport be cleaned thoroughly before each use because tape manufacturers lubricate their tapes, and the lubricant will gradually form a coating on the capstan idlers and may cause a loss of positive drive at the speed-determining capstan.

Tape Transport

Ideally, a tape transport mechanism would carry the magnetic tape across the recording and reproducing heads at an absolutely uniform velocity with no superimposed movements. However, because of slight eccentricities in rotating parts, resonance of various elements in contact with the tape, vibration of the tape itself, and tape speed variations caused by transitions from static to dynamic friction, all tape recorders exhibit speed errors. These speed variations are called flutter and wow in the audio recording field, and in instrumentation recording speed variations are usually referred to simply as *flutter*. However, far more serious errors are introduced by flutter in instrumentation recording than in audio recording. The accepted method of recording flutter and wow for audio purposes is to record a 3000-cps sine-wave signal on the recorder under test. This is then played back into a flutter bridge which consists of a limiter, FM discriminator, and meter. Any flutter and wow in the recorder would frequency-modulate the 3000-cps signal and result in a reading on the meter. Generally, only those flutter components up to 300 cps are measured, and this is accomplished on an r.m.s.-value basis.

The above procedure is unsatisfactory for instrumentation recording purposes. First, the flutter-frequency components above 300 cps are equally important in their effect on the recorded data; and secondly, a peak-to-peak value of the modulation components is of significance. For instrumentation recording, it is common to make flutter measurements by using an FM record amplifier with an unmodulated carrier, whose center frequency is produced at the 60-ips tape speed, and to record this carrier frequency on the tape. It is then played back through an FM reproduce amplifier (demodulator). The modulation products introduced by flutter are presented to an oscilloscope, where instantaneous peak-to-peak values can be observed and measured. These signals are proportional in amplitude to the speed variations which produced them. The readings are taken and plotted on a cumulative basis, using a low-pass filter having a precise shape and a cut-off frequency which can be opened up progressively to 10 kc.

While straightforward mechanical design can produce satisfactory flutter performance for high-quality audio recorders, a much greater degree of ingenuity and refinement is required for instrumentation equipment. Most tape equipment manufacturers agree that, considering only design, it would be ideal to just eliminate rotating parts! This being a dream, the practical approach has been to reduce the number or to isolate them as much as possible so their effects are minimized. The elements involved in a simple machine are (see Fig. 5):

a. Supply reel—feeds out tape and sometimes provides hold-back tension to insure intimate contact of the tape with the heads. Fitted with a motor for rewinding the tape, and a brake to decelerate the reel rapidly and smoothly when tape motion is stopped. Hold-

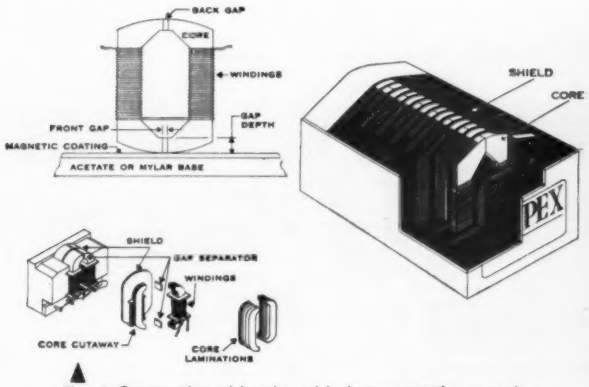
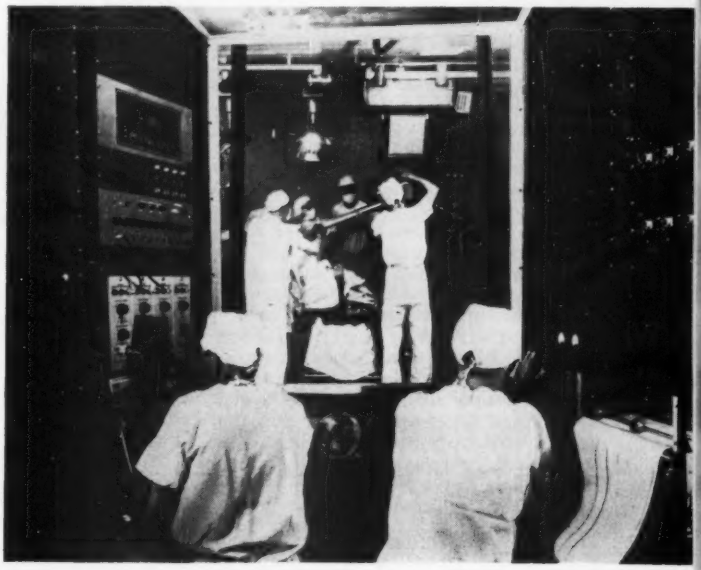
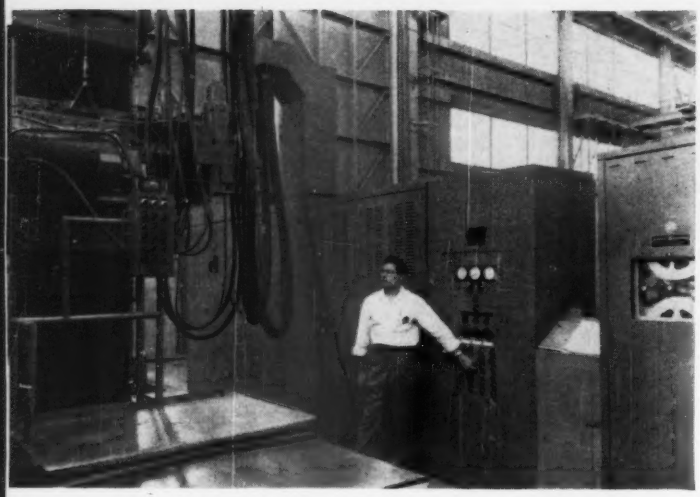


Fig. 4. Construction of head used in instrumentation recorder.



Surgical theater of neurosurgical suite at Mt. Zion Hospital in San Francisco, seen from control room. The tape recorder seen between the two operators and the ink writer at right make permanent record of patient's reactions to test stimuli.



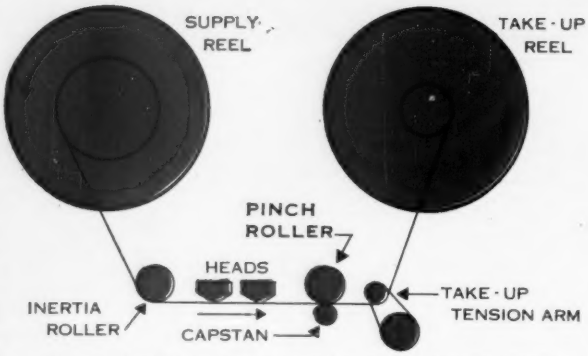


Fig. 5. Simplified diagram of a basic tape transport system.

◀ A large profiling machine programmed by tape. The continuous tool path for machining intricate shapes is recorded, and then followed with great accuracy by a servo system. Many aircraft and missile manufacturers employ such machine-tool controls.

back tension can be derived by either energizing the rewind motor in an opposing direction, by applying the brakes, or by other means.

b. Inertia roller—connected to a flywheel and serves to smooth out variations in tape speed which could be caused by uneven torque or motion of the supply reel.

c. Magnetic record and reproduce heads—whose function has already been described.

d. Capstan—moves the tape at a constant linear velocity and is often driven by a constant-speed synchronous motor. Pressure between tape and capstan is maintained by a solenoid-operated spring-loaded "pinch roller."

e. Take-up tension arm—is spring loaded to take up the normal slack caused when tape motion is first started until the take-up reel reaches full rotating velocity. This arm also serves to stop tape motion in the event of tape breakage.

f. Take-up reel—takes up tape during normal playing and provides for fast-forward tape motion when shuttling tape. Provided with a motor for this purpose and with a brake to decelerate the reel rapidly and smoothly when tape motion is to be stopped.

This is obviously an over-simplified description of a tape transport, but it is the basic configuration used on nearly all present-day audio recorders and some medium-performance instrumentation recorders. The recorder shown has an *open-loop tape-drive* system in which reel variations are isolated from the head by the inertia idler and the tape-driving capstan. Two other tape drive systems, developed to minimize flutter, are in common use. They are:

Closed-Loop Drive. Faster starts are possible with this drive, since the turnaround idler is light and quickly accelerated. Supply and take-up-reel speed isolation is provided by clamping the tape to both sides of the capstan. By reducing the unsupported length of tape in the head area, some of the flutter is of a higher frequency and consequently lower amplitude. This is the most popular drive used for instrumentation recorders (see arrangement of Fig. 6).

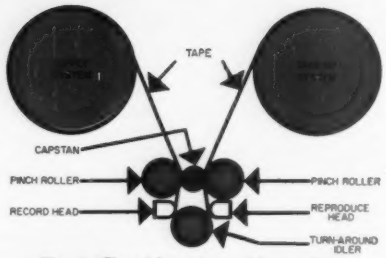


Fig. 6. Closed-loop tape drive system.

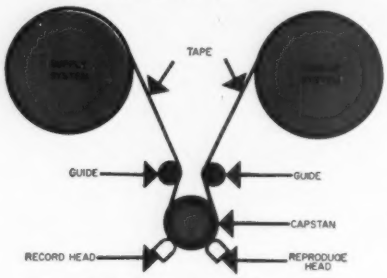


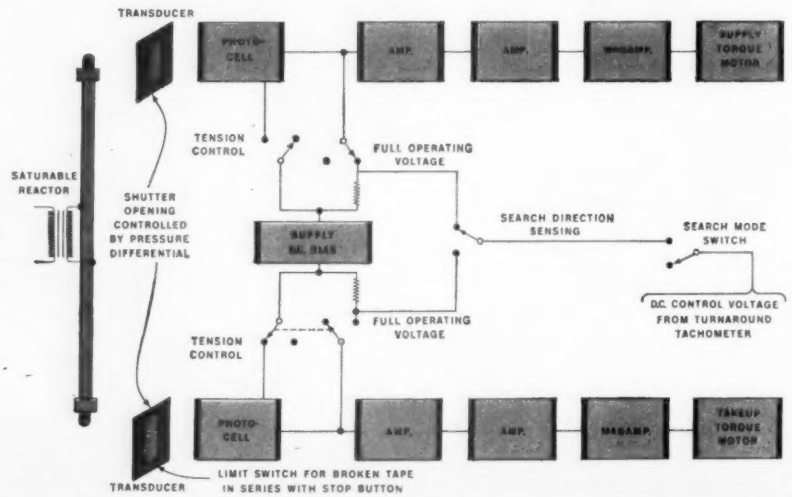
Fig. 7. Zero-loop tape drive system.

Zero-Loop Drive. Although this drive offers the advantage of zero unsupported length of tape, and many machines have been manufactured using this configuration, its performance has not been enough better to justify the cost of the critical manufacturing tolerances required. This drive is becoming less popular, but is shown because it is still in use (see Fig. 7).

Various methods have been employed for providing uniform hold-back and take-up tension for instrumentation recording, for these tensions play an important part in determining flutter, long-term timing accuracy, and the guiding of the tape uniformly across the heads. In audio recorders, simple arrangements are often completely satisfactory—such as a felt pressure pad against a fixed guide or linear torque-*versus*-speed supply and take-up motors. Instrumentation recorders use one of a variety of sophisticated designs. The most elaborate employ true tension

(*Continued on page* 86)

Fig. 8. Air-tensioning servo system. Differential air pressure on both sides of tape when tension changes actuates diaphragm that controls light intensity passed to photocells. Output is amplified and fed via magnetic amplifier to reel motors.



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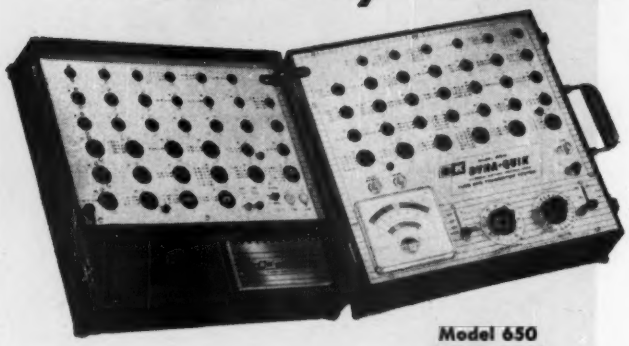

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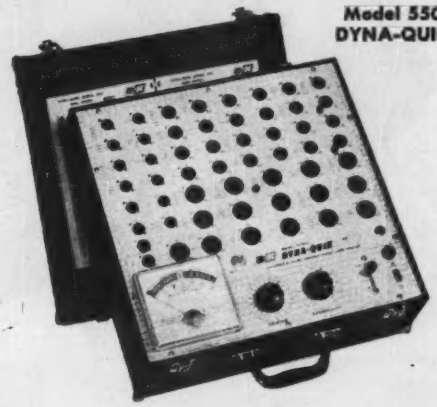

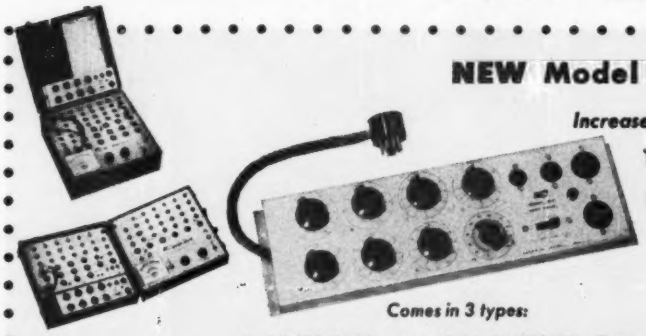

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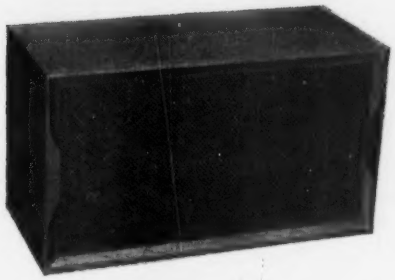


ACOUSTIC SUSPENSION SPEAKER SYSTEM KIT

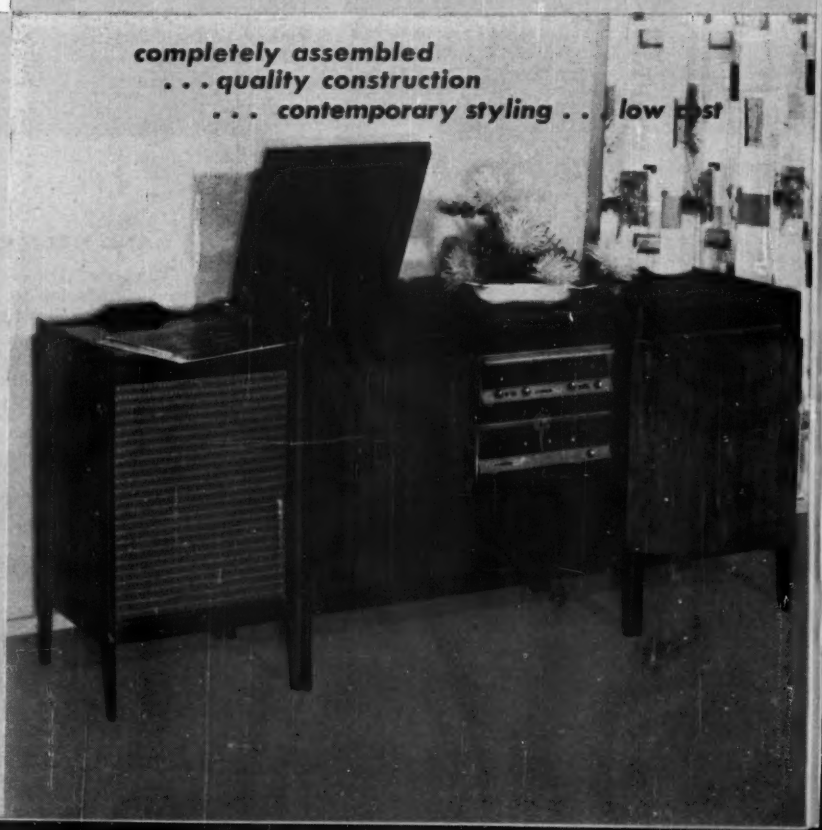
Its "bookshelf" size belying its gigantic capabilities, this amazing unit outperforms speakers 4-times its size. A 10" acoustic suspension woofer and two "dispersed-array" cone tweeters deliver high-fidelity tone with fantastic brilliance over the entire range of 30-15,000 cps, ± 5 db. Preassembled cabinet in choice of finishes or unfinished woods. Measures 24" L x 11½" D x 13½" H. 28 lbs.

Model AS-10M or **W** (mag. or wal.)...$6.50 dn. **$64.95**
Model AS-10U (unfinished)...$6.00 dn. **$59.95**

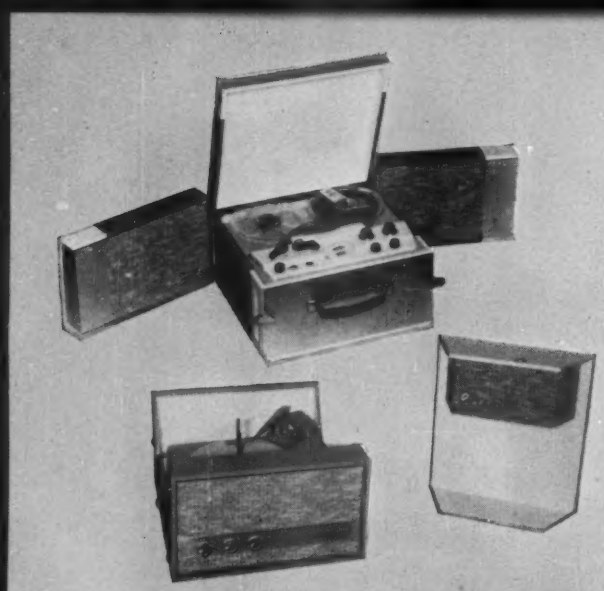
STEREO EQUIPMENT ENCLOSURE ENSEMBLE

Now, just in time for Christmas, Heathkit introduces new factory-assembled, ready-to-use equipment and speaker cabinets designed to house complete monophonic or stereophonic systems. The cabinets, resplendently styled in a timeless and universally compatible motif, are available in rich hand-rubbed walnut or mahogany finishes . . . or unfinished if desired. ¾" stock is used for all exterior panels and supports; solids for edgings, furniture grade veneers for front and side panels and shelves. Versatile in accommodations, the center cabinet has room for all components of a complete stereo or mono hi-fi system except speakers. The changer compartment will accept any Heathkit record changer or most tape recorders. The storage compartment holds records and tapes or using an accessory slide-out drawer may be used for a tape recorder. Two shelf compartments accept tuners and amplifiers. The power amplifier compartment will hold any Heathkit stereo power amplifier, a pair of UA-2 mono amplifiers or any single mono amplifier. The handsome speaker-wing cabinets in two models for 12" and 15" speakers are designed to blend into the flowing lines of the center cabinet and are perfectly acceptable as single console speaker enclosures. Adapter rings are provided for using other size speakers, while a special port is provided for installation of a horn-type tweeter.

Complete ensemble as low as $133.50. Send for details in FREE HEATHKIT CATALOG.



HEATHKIT®. . . for finer



PORTABLE 4-TRACK STEREO TAPE RECORDER KIT

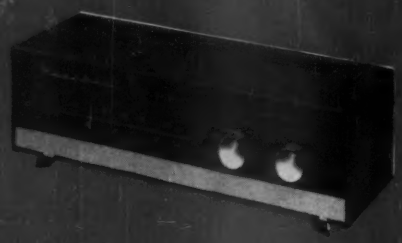
What better gift than this? . . . a compact portable tape recorder just waiting to record the caroling, frolicking family joys of the holiday season! You'll thrill to the natural stereophonic sound of this new unit that also serves as a hi-fi, power center for your tuner and record player. Tape deck and cabinet are preassembled.

Model AD-40. . .$18.00 dn., $16.00 mo. **$179.95**

STEREO/MONO PORTABLE STEREO PHONO KIT

Thrill to your favorite Christmas recordings in life-like stereo! This GD-10 offers you complete stereo and mono operation *plus* portable convenience. Handsome aqua and white two-tone vinyl clad cabinet and four-speed automatic changer come preassembled—you build only the amplifier in just a few enjoyable hours. Changer has turnover diamond and sapphire stereo cartridge. Complete tone controls. Measures 15½" W x 18" D x 8⅝" H. 28 lbs.

Model GD-10. . .$7.00 dn., $7.00 mo. **$69.95**



HIGH FIDELITY AM TUNER KIT

Here is the AM counterpart of the best selling Heathkit FM-4 tuner bringing you high fidelity AM reception plus many extras. Switch selection of broad or narrow band width, flywheel tuning, edge-lighted slide-rule dial, built-in antenna, self-powered. Styled to match Heathkit FM-4.

Model AJ-29 . . . . . **$29.95**

AUTOMATIC RECORD CHANGER KIT

Jam-proof mechanism . . . quick-change cartridge holder . . . "muting" switch . . . and "size-selector" for intermixing 7", 10" and 12" records of the same speed! Holds up to 10 records, for hours of delightful stereo or mono listening enjoyment.

Model AD-40 . . **$49.95** to **$54.95** depending on cartridge.

Other models from $22.95. Send for FREE Heathkit catalog today!

EDUCATIONAL KIT

Perfect gift for all ages . . . a basic course in radio that teaches radio theory in a way you can understand. Actual experiments are performed with radio parts supplied leading in successive steps from the construction of a simple crystal radio to a genuine regenerative radio receiver. Designed as a continuation of the popular EK-1 Educational Kit—but equally valuable as a starting point in radio electronics.

Model EK-2A . . . $ ea. **$19.95**

HAND-HELD CITIZENS BAND TRANSCEIVER

The perfect HEATHGIFT for everyone on your shopping list! No license required . . . anyone can use this 2-way radio! Operates up to a mile between units . . . more with regular Citizens Band stations. It's ideal for hunting, fishing, boating . . . most anywhere you need 2-way communications. Features 4-transistor circuit; fixed-tuned, super-regenerative receiver and crystal-controlled transmitter. 3 lbs.

Model GW-30 (kit) . . . . . **$32.95** (64.95 a pair)
Model GWW-30 (wired) . . . . . **$50.95** (99.95 a pair)

DELUXE 2-WAY CITIZENS BAND TRANSCEIVER

This Christmas, give the best that money can buy in a Citizens Band Transceiver. The efficient superheterodyne receiver has an automatic "noise limiter" and adjustable "squelch" control, single channel "crystal" or continuous tuning. The transmitter has press-to-talk microphone and can be switched to any of the three crystal-controlled channels. Choose the "under-dash" DC mobile model or "fixed" station AC unit. 11 lbs.

Model GW-10 (kit) . . . . . $6.30 dn., $6.00 mo. **$62.95**
Model GWW-10 (wired) . . . $10.00 dn., $9.00 mo. **$99.95**

(specify 117 v AC or 6 or 12 v DC model)

gifts of lasting value!

"SPACE-SAVER" 3" DC OSCILLOSCOPE KIT

Almost, but not quite tiny enough for a Christmas stocking, this compact scope saves valuable work-bench space, while providing versatile features to fill a multitude of applications in medical, industrial and general service fields. Ideal as a "read-out" for computers; for wave-form observations; and for voltage, frequency and phase shift measurements. Identical vertical and horizontal DC coupled amplifier, transformer operated power supply—and many more outstanding features.

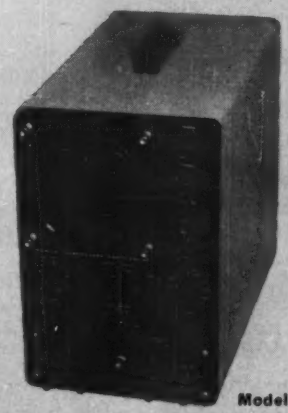
Model IO-10...14 lbs....$8.00 dn., $8.00 mo.....**$79.95**

LABORATORY 5" OSCILLOSCOPE KIT

A real time-saver in audio and TV service work, where the same sweep frequencies are used over and over; the IO-30 offers two extra, switch-selected, pre-set sweep frequencies. Kit is supplied with capacitors appropriate for TV service giving preset frequencies of 30 cycles and 7875 cycles; by changing capacitor values, any two desired preset frequencies within the sweep frequency range can be made available.

Model IO-30...22 lbs....$7.70 dn., $7.00 mo.....**$76.95**

2 new scopes . . . just in time for Christmas!



Model IO-30

Model IO-10

PHONE AND CW TRANSMITTER KIT

Brand-new in every respect, the DX-60 combines smart styling, top-flight performance and low Heathkit cost to offer the "Amateur rig" value of the season. Ideal for General class Amateurs, the Transmitter may also be run at reduced power for novice operation. Covers 80 through 10 meters. Power input: 90 watts peak, carrier controlled phone or CW. 27 lbs.

Model DX-60...$8.30 dn.....**$82.95**

2, 6 & 10 METER TRANSCEIVER KITS

Make a hit with the "Hams" on your gift list by giving one of these outstanding transceivers. All are identically styled to the popular Heathkit CB-1 Citizens Band Transceiver; feature variable-tuned superregen receivers; 5-watt input crystal-controlled transmitters. All are supplied with mike, power cables and AC power supply.

Model HW-30...(2 meter).....**$49.95**

Model HW-20...(6 meter) or **HW-10** (10 meter).....**$39.95** ea.

DELUXE VACUUM TUBE VOLTMETER KIT

Hobbyist and professional alike will prize this useful gift. This brand-new Heathkit features big, easy-to-read 6" meter with multi-color scales; high-visibility switches; greater accuracy; longer meter scales; special low voltage AC scales; broader frequency response; thumb-wheel controls and easy-access adjustments.

Model IM-16...7 lbs.....**$32.95**

SEND FOR YOUR FREE HEATHKIT® CATALOG

You'll find the perfect gift for family or friends among the over 200 Heathkit items for hi-fi fans, amateur radio operators, students, technicians, marine enthusiasts, sports car owners and hobbyists. *And* many Heathkit products are now available in both wired and kit form!

ORDER DIRECT BY MAIL OR SEE YOUR HEATHKIT DEALER

ORDERING INSTRUCTIONS

Fill out the order blank below. Include charges for parcel post according to weights shown. Express orders shipped delivery charges collect. All prices F.O.B. Benton Harbor, Mich. A 20% deposit is required on all C.O.D. orders. Prices subject to change without notice.

HEATHKIT®

HEATH COMPANY,
Benton Harbor 15, Michigan

Please send the following HEATHKITS:

ITEM	MODEL NO.	PRICE

Ship via ( ) Parcel Post ( ) Express ( ) COD ( ) Best Way

( ) SEND MY FREE COPY OF YOUR COMPLETE CATALOG

Name _____

Address _____

City _____ Zone ___ State _____

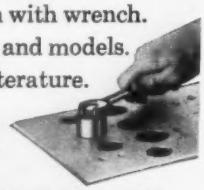
Dealer and export prices slightly higher.

QUICKLY CUT HOLES
in metal, plastics, hard rubber...

ROUND SQUARE KEY "D"

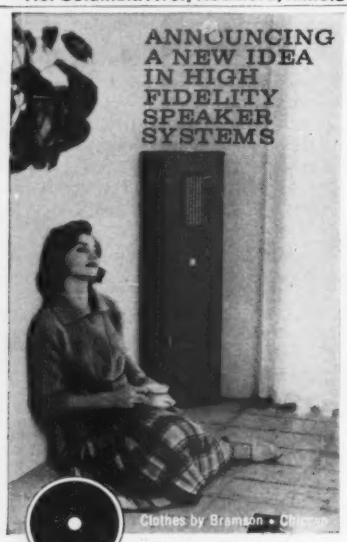
GREENLEE CHASSIS PUNCHES

Make smooth, accurate openings in 1½ minutes or less . . . for sockets, plugs, controls, meters, panel lights, etc. Easy to use . . . simply turn with wrench. Many sizes and models. Write for literature.



GREENLEE

GREENLEE TOOL CO.
1961 Columbia Ave., Rockford, Illinois



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THE NEW
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Now you can buy the ultimate in tweeters, the new IONOVAC . . . the only speaker using ionized air to generate and transmit sound. Clear reproduction from 3,500 to 20,000 cps and above. Available as an "add-on" unit or complete with high compliance woofer and mid-range speakers in distinctive baffles. Free literature explains operation and models available.

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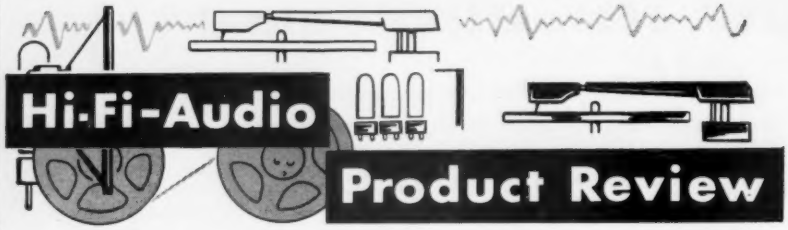
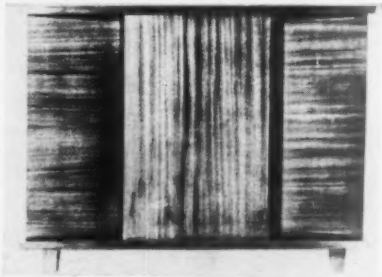


UNITIZED SPEAKER SYSTEMS

Radio Frenquency Laboratories, Inc., Audio Products Div., Boonton, N.J. has introduced a new series of dual integrated speaker systems for stereo or



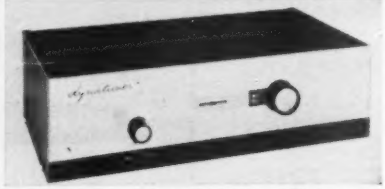
mono, but housed in a single cabinet.

Known as "spacial fidelity," the systems are available in a variety of sizes, wood finishes, and period styles. Placement in the room is said to be non-critical for stereo or mono listening.

DYNATUNER KIT

Dynaco, Inc., 3912 Powelton Ave., Philadelphia 4, Pa. has brought out its "Dynatuner," an FM tuner available as a kit or factory-wired. Said to utilize a new design that embodies high sensitivity, high selectivity, and low distortion, the tuner may be aligned precisely at any time by the user, with the help of its tuning meter.

The circuit makes extensive use of etched boards, and the planetary drive system for the tuning capacitor elimi-



nates the need to string a dial cord. Sensitivity is listed as better than 4 microvolts by IHFM test standards, or 1 microvolt for 20 db of quieting. Distortion is said to be less than 0.1% with 100% modulation, and less than 0.25% at most usable signal levels.

HI-FI HEADSET

Telex, Inc., Communications Accessories Div., Dept. KP, 1633 Eustis St., St. Paul, Minn. has announced its "Dyna-Twin" headset, designed for high-fidelity mono or stereo listening as well as other applications, including communications equipment.

Claimed response is 30 to 15,000 cps. Construction is lightweight and rugged. For two-way communication, the headset is equipped with an integrally boom-mounted microphone of any type desired.

Standard impedance is 6 ohms for each phone. Sensitivity is listed as 80 db above .000204 dyne/sq. cm. per 1 milliwatt input. The phones feature air-filled neoprene and a seven-way headband adjustment for wearing comfort.

STEREO PHONO COMPONENTS

Dyna-Empire, Inc., 1075 Stewart Ave., Garden City, N.Y. has announced its "Troubador" system, consisting of the *Audio Empire* Model 208 3-speed turntable and the Model 98 tone arm, both mounted on a walnut base. The assembly is available in satin gold or satin

chrome finish to match the color scheme of most other components.

This organization's free do-it-yourself "Stereo/Balance" kits are being made available at high-fidelity dealers throughout the country.

REVERB UNIT

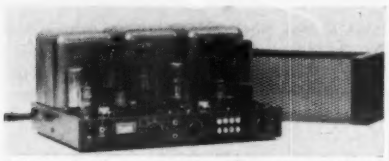
Checker Electronics Corp., Grayslake, Ill. has announced that its "Reverba-Sonic" reverberation unit is available both as a table model (T-501) and floor model (T-500). The amplifier used in each is rated at 8 watts output; tube complement includes a 12AX7, 6L6GB, and 5Y3GT.

Full information is available from the manufacturer.

DUAL 60-WATT AMPLIFIER

Acro Products Co., 369 Shurs Lane, Philadelphia, Pa. has announced its Stereo 120, a dual power amplifier featuring 60 watts per channel and available as a kit or factory-wired. The circuit combines the "Ultra-Linear" principle with "hybrid feedback" for stability and very low distortion, said to be less than 1% IM at 60 watts; less than 0.5% IM at 50 watts.

The amplifier uses extensive printed circuitry for ease in construction. An



internal illuminated meter is provided for easy bias adjustment and circuit check. Full details are available from the manufacturer.

STEREO CONTROLS

Clarostat Mfg. Co., Dover, N. H. has announced a line of complete control packages for stereo amplifiers. Highlighting the new line is a matched-element dual control, available in both the Series 37 and Series 47 types.

The company also is offering a complete line of controls with or without switch, including pads, dual concentrics, clutch-types, and others. Complete details are available on request.

SPEAKER ENCLOSURE

Homewood Industries, 26 Court St., Brooklyn 1, N.Y. has brought out its Model 8 unfinished speaker enclosure designed to accommodate a 12-inch driver or, with an adapter, an 8-inch unit. Measuring 18 inches wide, 29½ inches high (including the 5-inch legs supplied with the unit), and 17 inches deep, the enclosure is built of birch veneer ¾-inch plywood.

Surfaces are smooth-sanded, ready to be finished by the user. Full-face grille cloth covers the front. Acoustic damping material has been factory installed.

REPLACEMENT KNOBS

GC Electronics Co., 400 South Wyman St., Rockford, Ill., has announced a replacement package of phono knobs covering leading makes of record changers. The initial phase of the new line includes 36 different items.

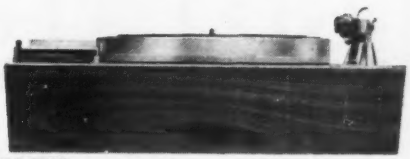
Service technicians will find these knobs on colorful displays at their parts distributors. Replacements now in the line cover *Collaro*, *Monarch*, *V-M*, and *Webcor* changers.

INTEGRATED STEREO AMPLIFIER

Stromberg-Carlson, 1477-010 North Goodman St., Rochester 3, N.Y. is offering a new combination stereo preamp-power amplifier. Designated as Model

ASR-6-60, it provides power output of 22 watts per channel (music power, IHFM standard), or 18 watts per channel continuous power.

IM distortion is listed at 1% for rated output; harmonic distortion is 0.4% at 18 watts, 1 kc. Response is given as 20 to 20,000 cps ± 0.5 db. Separate clutch-type bass and treble controls are provided on each channel.



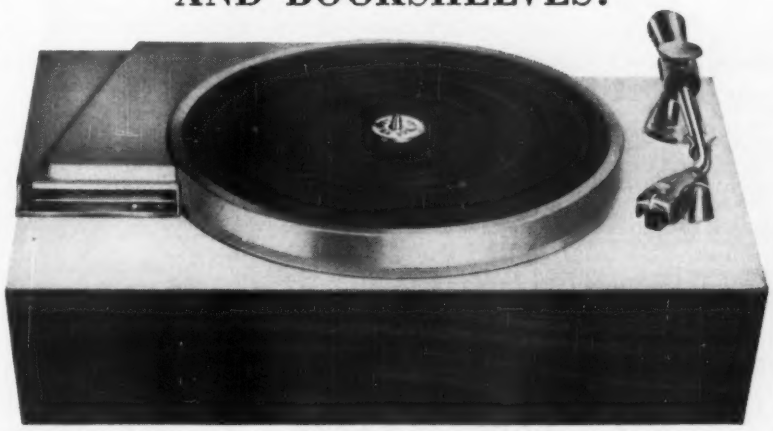
"REK-O-KUT"– the safest word you can say to your dealer

For sixteen years, Rek-O-Kut has been synonymous with highest quality in turntables. As other brands have risen, fallen and even completely disappeared, Rek-O-Kut has won consistent acclaim as the overwhelming choice in its field. In performance ratings as well as engineering contributions to turntable design, Rek-O-Kut has compiled a record unchallenged by any other turntable producer. Now, this tradition is again emphasized by the introduction of the N-34H STEREOTABLE... a professional quality, two speed (33⅓ and 45 rpm) turntable. Quiet power is furnished by a Rek-O-Kut hysteresis synchronous motor and an efficient new belt-drive system. Speeds can be changed even while the table is rotating, merely by pressing a lever.

The N-34H is a symphony of crisp, clean lines accentuated by the unusual deck design. Mated with the new tapered base, the N-34H becomes one of the proudest and most beautiful components ever to grace a home music system. See it at your dealer's.

N-34H STEREOTABLE only—$79.95 net. Shown with new Rek-O-Kut Micropoise Stereo Tonearm, Model S220, $29.95 net. Tapered base in hand-rubbed, oiled walnut, $14.95.

A NEW DIMENSION IN TURNTABLES–12⅝" x 19"– DESIGNED TO FIT NARROW CABINETS AND BOOKSHELVES!



SPECIFICATIONS: *Noise Level:*—53db below average recording level; *Wow and Flutter:* 0.15% *Drive:* Nylon, neoprene-impregnated endless belt. 2-Speeds, 33⅓ and 45 rpm.

NOTE: COMING SOON . . . ANOTHER GREAT DEVELOPMENT . . . Rek-O-Kut AUTO-POISE—makes any Rek-O-Kut tonearm you buy now—fully automatic

REK-O-KUT STEREOTABLES

Export: Morhan Exporting Corp., 458 Bway, N.Y. 13
Canada: Atlas Radio, 50 Wingold Ave., Toronto 19

Rek-O-Kut Company, Inc., Dept EW-12
38-19 108th Street, Corona 68, N.Y.
Please send me complete details on the new N-34H STEREOTABLE:

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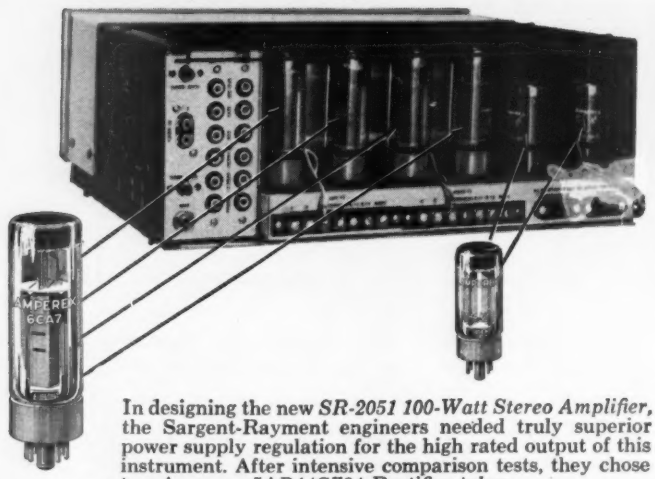
Address _____

City _____ Zone ____ State _____

2 for the money

circuit by SARGENT-RAYMENT | *tubes by* Amperex®



In designing the new *SR-2051 100-Watt Stereo Amplifier*, the Sargent-Rayment engineers needed truly superior power supply regulation for the high rated output of this instrument. After intensive comparison tests, they chose two Amperex 5AR4/GZ34 Rectifier tubes.

For Power Output, they wanted a tube with high efficiency and high sensitivity, produced to standards of absolute uniformity, in order to assure maximum power output, plus inaudible distortion. Their goal was achieved with four Amperex 6CA7/EL34's

These and many other Amperex 'preferred' tube types have proven their reliability and unique design advantages in the world's finest audio components.

Applications, engineering assistance and detailed data are always available to equipment manufacturers. Write: Amperex Electronic Corp., Special Purpose Tube Division, 230 Duffy Avenue, Hicksville, L. I., New York.

ask Amperex

about hi-fi tubes for hi-fi circuitry

OTHER AMPEREX TUBES FOR QUALITY HIGH-FIDELITY AUDIO APPLICATIONS

POWER AMPLIFIERS
6CA7/EL34: 60 w. distributed load
7189: 20 w., push-pull
6BQ5/EL84: 17 w., push-pull
6CW5/EL86: 25 w., high current, low voltage
6BM8/ECL82: Triode-pentode, 8 w., push-pull

VOLTAGE AMPLIFIERS
6267/EF86: Pentode for pre-amps
12AT7/ECC81: } Twin triodes, low
12AV7/ECC82: } hum, noise and
12AX7/ECC83: } microphonics
6BL8/ECF80: High gain, triode-pentode, low hum, noise and microphonics

RF AMPLIFIERS
6ES8: Frame grid twin triode
6ER5: Frame grid shielded triode
6EH7/EF183: Frame grid pentode for IF, remote cut-off
6EJ7/EF184: Frame grid pentode for IF, sharp cut-off
6AQ8/ECC85: Dual triode for FM tuners
6DC8/EBF89: Duo-diode pentode

RECTIFIERS
6V4/EZ80: Indirectly heated, 90 mA
6CA4/EZ81: Indirectly heated, 150 mA
5AR4/GZ34: Indirectly heated, 250 mA

INDICATORS
6FG6/EM84: Bar pattern
IM3/DM70: Subminiature "exclamation" pattern

SEMICONDUCTORS
2N1517: RF transistor, 70 mc
2N1516: RF transistor, 70 mc
2N1515: RF transistor, 70 mc
IN542: Matched pair discriminator diodes
IN87A: AM detector diode, subminiature

QUIETROLE
LUBRI-CLEANER
The first of its kind and still best for silencing noisy controls and switches in TV, Radio & all Electronic Equipment.

Spray it or Drop it

Just Press and whoosh aerosol QUIETROLE quickly and easily cleans as it lubricates.

Or, if you prefer, use this handy eye-dropper and just a drop or two of quality QUIETROLE does the job perfectly.

Either way, make sure it's QUIETROLE

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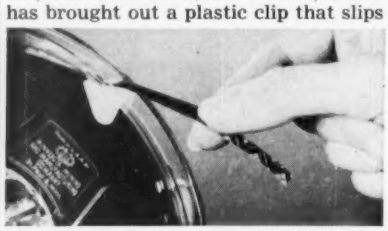
67 Ontario St., S., Kitchener, Ont.

Other features include filters for rumble and scratch, loudness contour switch, balance control, channel-reverse switch, program selector, master gain control, and "A + B" center-speaker terminals.

TAPE CLIPS

Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn. has brought out a plastic clip that slips

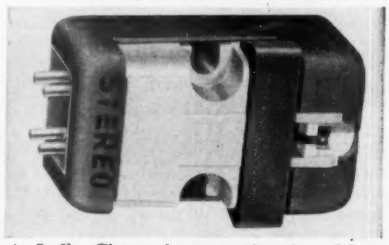


between the flanges of tape reels to hold loose ends of the tape securely in place.

Called the "Scotch" brand Tape Clip, the product is being merchandised in packages of ten. Additionally, one clip will be packaged with each roll of "Scotch" brand recording tape in the near future.

STEREO CARTRIDGE

United Audio Products, 12 W. 18 St., N.Y. 3, N.Y. has announced its new magnetic stereo cartridge, Model DMS-900. Designed to track at less than 2 grams stylus force, the new pickup has a claimed response of 20 to 20,000 cps

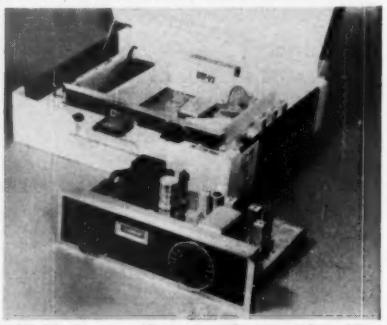


± 3 db. Channel separation is said to be 28 db at 1000 cps.

Output level is 6 mv. at 5 cm./sec. at 1000 cps per channel, with a 2 db maximum level difference between channels. The DMS-900 is said to maintain adequate channel separation up to 15 kc. Stylus interchange is accomplished readily by a direct snap-in assembly.

SCOTT TUNER KIT

H. H. Scott Inc., 111 Powdermill Rd., Maynard, Mass. has announced a new tuner in kit form. Known as Model



LT-10, it uses the manufacturer's wide-band design and silver-plated front end,

said to make for high sensitivity and selectivity and freedom from drift. The front end is pre-assembled, pre-aligned, and pre-mounted on the chassis. All tube sockets, terminal strips, and jacks also are pre-mounted.

The kit is supplied in a special "Kit-Pak" box which opens to provide a work-table, with colored illustration book mounted in the cover. Parts come mounted on charts. All wires are color-coded, pre-stripped, pre-cut, and pre-tinned. Final alignment is done with the help of a built-in tuning meter.

STEREO RECEIVER

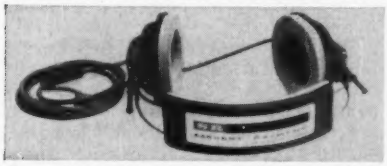
Crosby Electronics, Inc., Syosset, L.I., N.Y. has introduced its Model 650 stereo receiver, consisting of an AM-FM stereo tuner, stereo preamplifier, and dual 14-

watt power amplifiers integrated on one chassis.

The instrument features push-button program selectors; individual bass, treble, and level controls on each channel; a blend control; center channel feed; illuminated station indicators; and other stereo and mono control facilities.

STEREO HEADSET

Sargent-Rayment Co., 4926 E. Twelfth St., Oakland 1, Calif., has introduced a new stereo headset designed



for private listening as well as monitoring.

Claimed response is 60 to 12,000 cps. A molded aluminum casing is said to increase bass response as well as lend ruggedness to the unit. Comfort while wearing the headset is helped by a sealed outer surface of grey cellular vinyl chloride.

STEREO ARM-CARTRIDGE

Fairchild Recording Equipment Corp., 10-40 45th Ave., Long Island City 1, N.Y. has announced an integrated arm and stereo cartridge.

Known as the Model 500, it embodies a newly designed "arm-transport" and the Model SM-2 cartridge. An outstanding feature of the arm is its anti-skating characteristic, which is said to overcome the pulling force on the cartridge by a method that utilizes a force equal in magnitude and opposite in direction. This results in equal groove pressure, claimed to provide better tracking and lower distortion.

The cartridge is said to maintain channel separation linearly, at 20 db

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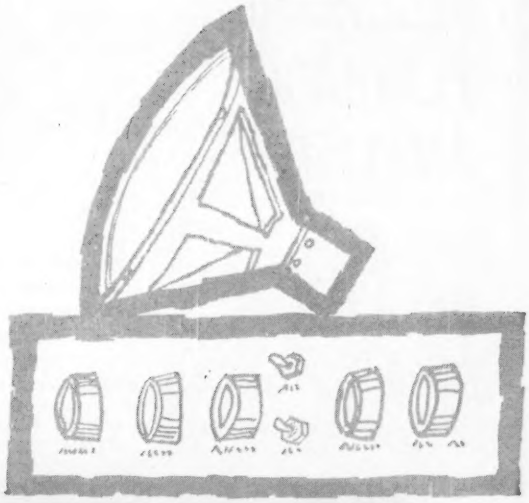
the changer designed with the system in mind



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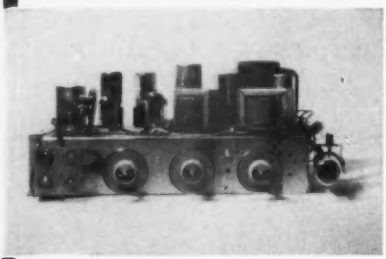

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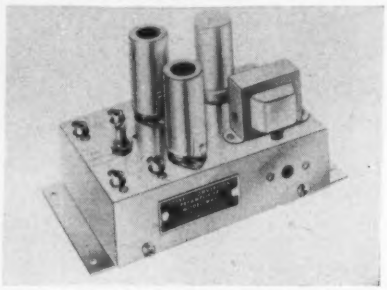
STEREO PREAMP

Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill. has introduced its Model M65 stereo preamplifier, designed



for boosting the signal level from magnetic cartridges so that they can be used as replacements in systems originally built for ceramic cartridges.

Self-powered, the preamp has dual input and output jacks, a 4-position selector switch, and provides two stages of preamplification and equalization on each channel. The M65 also can be used as a preamp for tape playback heads and microphones.

AUDIO CATALOGUES

KARLSON ENCLOSURES

Karlson Associates, Inc., West Hempstead, N.Y. is offering an illustrated brochure, entitled "Stereosonics by *Karlson*," that explains the principles of the company's enclosure and lists the firm's complete line of factory-built and kit enclosures.

DUAL CONTROLS FOR STEREO

Clarostat Mfg. Co., Inc., Dover, N.H. is now offering its "Stereo Report No. 60," an engineering report on matched-element dual controls for use in stereo audio equipment. Methods used in measuring tracking characteristics, formulas, and graphic displays are included. [30]

Sound Directivity

(*Continued from page* 33)

subject, sitting nearby, heard *via* earphones, the sounds picked up by "Oscar's" microphones. This seemed to move the apparent source of the sound away from the loudspeaker and into the headphones. Some sense of "sidedness" remained, however, as the sound would seem to be more at one ear than the other.

This test indicates that tiny movements and tremors of the subject's head are necessary in order that the source of the sound appears to be external. Even with the subject's head clamped as securely as possible, such tiny movements take place and succeed in "externalizing" the sound source. If such movements are non-existent, as with the securely clamped dummy head, the "externalizing" effect does not take place. When the movements were present, the small changes in relative amplitudes and phases of the sounds striking the two ears were sufficient to provide external localization.

As a follow-up to this experiment, the subject with "Oscar" attached to his head was placed in front of a loudspeaker emitting a sine wave (Fig. 2B). Then networks A and B of Fig. 1 were adjusted so that the sounds reaching the subject's ears had amplitudes and phases corresponding to a sound source at some particular angle to the side. The subject got a clear and accurate sensation of a sound source at just such an angle.

To carry the experiment further, networks A and B (Fig. 1) were adjusted in such a manner as to violate the natural relations between relative amplitude and relative phase. This caused the sound source to appear diffused rather than sharp and led to large errors in identifying the true location of the source.

An arrangement of loudspeakers, as shown in Fig. 2C, was then set up in a reverberant room (Arnold Auditorium) with a reverberation period of about one second. Various speakers were actuated with a sine wave, and observers were asked to state from which speaker the sound appeared to be coming. The observers were free to move their heads and, even so, were unable to name the correct speaker with any degree of consistency.

The auditorium results arise from the fact that the relative amplitude and relative phase of the sound varies from point to point in the room, due to reflections. Thus, the subject has no accurate information on which to judge direction.

These results are based on a sinusoidal sound. Results are quite different for other sounds such as speech, music, and clicks. Such sounds can be located quite accurately, even in a reverberant room. Also, if a sine wave is turned off or on within a tenth of a second, thereby producing a transient, the direction of the source can be spotted accurately.

This series of tests provides some very interesting and fundamental information about how we determine the direction of sound sources. First, there must be slight head movements to keep the apparent source of the sound "external" to the observer. Second, the inter-aural amplitude and phase of the sounds reaching each ear must correspond to that arising from a real localized sound source, or the observer will be unable to determine its direction accurately.

Investigations of this nature are helping to give us a better understanding of how we perceive sound directivity, and thus will help in developing better and more effective sound systems. [30]

Britain's New TV Center

By

PATRICK HALLIDAY

BRITISH TV programming facilities have now been augmented by the $28,000,000 *BBC* TV Center at White City, London, claimed to be the largest ever built for TV.

When completed there will be seven main production studios, one 108 feet x 100 feet x 54 feet high, and two others 100 feet x 80 feet x 40 feet. The new center, now partially operational, has the seven studios and control rooms grouped around a seven-story circular office building and with an outer ring of buildings which include workshops and storage space for scenery.

Below the level of the 150-foot diameter central courtyard will be four "telerecording" areas, 85 dressing rooms, and a number of rehearsal rooms. The floor in the largest studio can be opened to reveal a 50 foot x 30 foot x 7½ foot deep pit which will be flooded with water for aquatic programs. The center has been designed to supply about 1500 hours of studio programs a year to the *BBC* network. Between 2500 and 3000 persons are needed to man the center. One main control desk channels all programs.

Meanwhile, a few miles away at Wembley, North West London, *Associated-Rediffusion*—one of the program companies for the rival Independent TV Authority—is now using what is claimed to be the world's largest studio designed and built expressly for TV work. It is 140 feet long x 100 feet wide x 50 feet high and cameras can be raised up to 30 feet. It is possible to lower a soundproof partition to divide this mammoth studio into two.

Both *BBC* and *A-R* are using five-position turret, 4½-inch image orthicon cameras which include facilities to fit *C.P.S. Emitron* pickup tubes when required. The *BBC* has recently announced a new prototype camera in which the entire optical assembly, including a long-range zoom lens, is housed within the camera, eliminating the usual external lens turret. [30]

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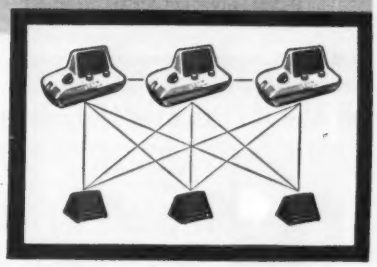

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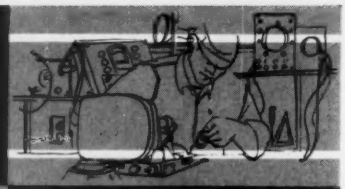
SERVICE INDUSTRY NEWS



THIS year's annual convention of the National Alliance of Television & Electronic Service Associations in Chicago, like its predecessors, set new records in attendance and in the show of strength. About a hundred local affiliates were represented by at least a director. A crowd of 468 attended the Grand Banquet alone, with total registration reported to exceed this figure by several hundred. Since the 1959 convention, 26 new local affiliates have been admitted to the national.

Reports were made on 40 subjects with which NATESA had been concerned over the past year, with progress noted on many of these. Included were phony schools, false advertising claims and warranties on CR and other tubes, captive service, DIY tube checkers, pay TV, and permanent serial numbers for TV sets. Showing accelerated activity in getting together with other segments of the electronic industries, there were reports on liaison with distributors through NEDA, liaison with BBB, relations with EIA, and union contacts in Texas. (Concerning NEDA, further progress was made less than three weeks after the convention. NATESA executive director Frank J. Moch and NEDA president Mauro E. Schifino held an exploratory, informal discussion jointly described as "an exchange of views on common problems" with the hope of achieving "mutual objectives of all segments of the industry." Follow-up meetings are planned.)

Also considered was the failure of some NATESA directors to fulfill their obligation to report back to local affiliates. New methods for exercising this function were evaluated.

An 11-point proposal embodying policy and procedural changes was brought before the executive council. Preliminary reports are not clear on what these points were specifically. Two were defeated, two carried, three pend further consideration, two were withdrawn by their proponents, and two were deemed not to require further consideration as they were already in force.

New NATESA Officers

Succeeding Mac Metoyer as president was Alphonse Benoit, Jr., New Orleans. Other officers include W. O. Hirschberg, St. Louis, secretary general; Nelson Burns (re-elected), Memphis, treasurer; Irving Toner, Buffalo, and George Carlson, Jamestown (both re-elected), as eastern v.p. and eastern secretary respectively; T. R. Nabors, Nashville, and John Graham, Columbus, as east central v.p. and secretary respectively; Harrol Eales, Oklahoma City, and Ralph Woertendyke, Salina, Kans., as west central v.p. and secretary; Winston Haines (re-elected), Burlingame, Calif., and Jim Humphrey, Seattle, as western v.p. and secretary.

Convention Reactions

Those in attendance, whether they were or were not NATESA members, tended to form favorable views on the manner in which the convention was conducted. Delegates representing ESDA of Western Penna., some of whom had earlier reservations about their membership in NATESA, are planning increased representation next year. Said Norman Falck, ESDA v.p., "I must now make a complete reversal in my thinking. If (we) ever should contemplate dropping out of NATESA, it would be the biggest mistake we could ever make."

Lou Hudson, president, and Russ Goode, v.p., of TSA of Detroit, also attended. Although often at odds with NATESA, this group was permitted to be represented despite the fact that it had failed to apply for admission two weeks in advance, as required. Russ Goode subsequently reported, in "TSA News," "Mac Metoyer presided at the meetings and did an excellent job of handling the proceedings so as to cover the many topics on the agenda in the least possible time and still maintain a democratic approach to some of the controversial issues." Concerning the people he met in Chicago, Goode had this to say: "The overwhelming majority were dedicated young men, handling a difficult job with a great deal of dexterity not ordinarily associated with the television service industry." Also of interest was his concluding note: "Eventually all associations of any significance will belong to a national association. It may take X number of years, but why not this year?"

An Editorial Footnote

Early in the proceedings, NATESA's executive council elected to throw the convention open to all interested persons. Unfortunately this action came too late as far as direct coverage by ELECTRONICS WORLD was concerned. Although present at an earlier NATESA gathering (see "Service Holds a Convention," November 1958, page 57), we were prevented from providing service readers with complete coverage because we were denied admission (along with all other members of the press) from all

sessions except those on the last day.

We had hoped to cover the convention directly this year. However, in view of our earlier experience, we notified the executive director of our intention in advance, asking for some assurance of a reasonable opportunity to attend meetings. After considering the request, the executive council failed to give such assurance. When the convention was finally thrown open, we were half a continent away.

However one feels about NATESA, there is no disputing the fact that it speaks for a far greater number of service people than any other group. As such, its activities are of interest and concern to the entire industry, and merit the thoughtful attention of all, whether pro, con, or undecided. As a medium of information for the industry, ELECTRONICS WORLD is obliged to give NATESA extensive coverage. But we cannot do so adequately without cooperation of the organization itself.

In other words NATESA itself, in recognition of its own position, must accept some responsibility for making it possible to keep its activities in the public eye. The decision for an open convention this year, although belated, is a welcome sign. It appears that members of the executive council were honestly concerned that open meetings would interfere with the business of the convention. Disrupters might have a field day. Members might feel hampered by the feeling that outsiders were looking over their shoulders. However things did not work out that way. Removing the barriers to attendance did NATESA more good than harm.

It is consequently to be hoped that we may look forward to open meetings or, at least, adequate press coverage next year—and that a decision along these lines will be made known *before* the convention takes place. If so, it may not be premature to say to Messrs. Moch, Benoit, *et al*, "See you next year!"

Massachusetts Advertises

Electronic Technicians Guild of Mass. is pushing its fall advertising campaign on local radio. It's an example of alert, cooperative action in an area where individual shops could not function effectively.

The program to be used is the Jerry Williams Show on local WMEX. Heard daily, this program has the largest audience response of any in its area. "ETG News" says: "The entire cost for 13 weeks is $1625, or $125 per week. However, with a total of 25 members participating, the cost per man, for a 13-week period, is only $65. A mere $5 a week per man. And for this you receive a spot announcement at the beginning, middle, and at the end of each program 6 nights a week. A total of 18 spots a week. Yes; one service call will more than pay for this type of advertising, which is a chance for ETG members only."

Service always needs better public relations. This cooperative effort makes it available at a cost that is prohibitive on an individual basis. [30]

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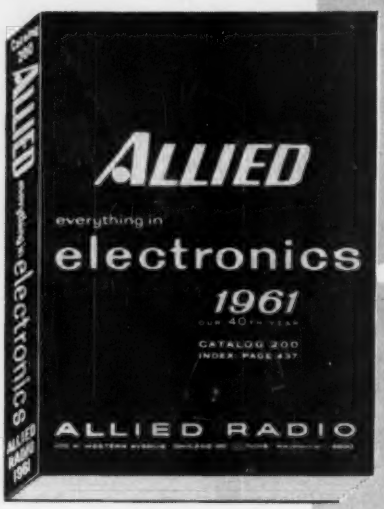

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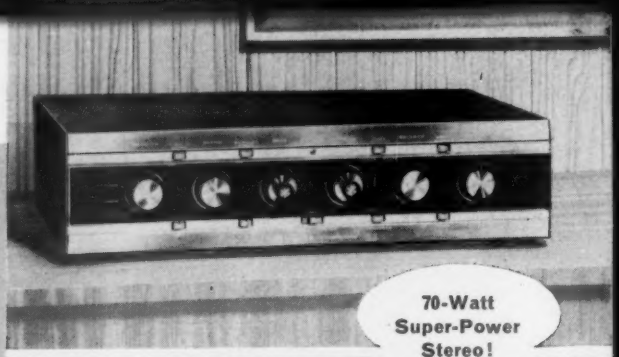

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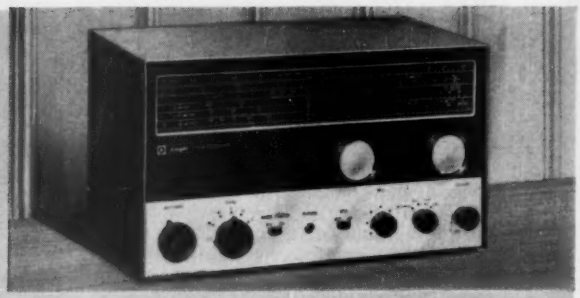

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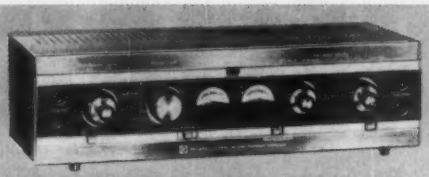

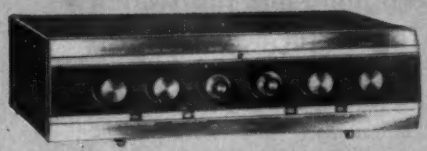

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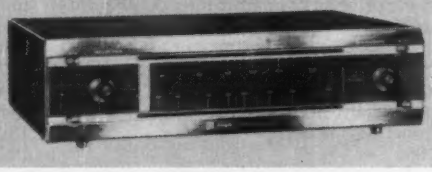

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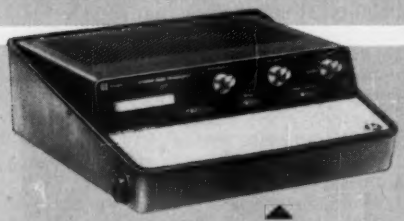

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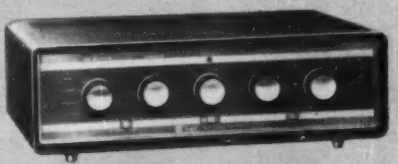

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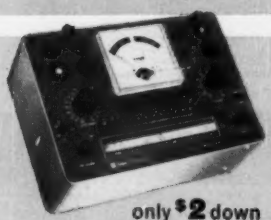

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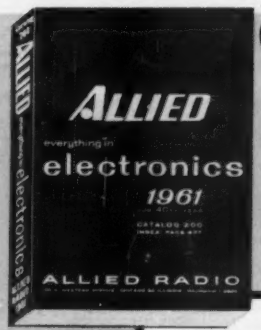

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TRANSISTOR RELIABILITY

Problems and solutions in designing and fabricating high-reliability transistors for use in new missiles.

By **D. S. HALACY**
Manager, Tech. Information Center
Motorola Semiconductor Products Inc.

PARADOXICALLY, the inherent reliability of the transistor is responsible for the vigorous efforts now being made for additional reliability improvement of several magnitudes. At the outset, the reliability of semiconductor devices, like the transistor, is several magnitudes higher than that of the vacuum tubes they replace. Such improvement makes feasible systems only hopefully dreamed of prior to about 1950.

For example, 6000 vacuum tubes in a missile or satellite would hardly be feasible, yet this number of semiconductors is not exceptional in present applications and the trend is rapidly upward. A large computer may well incorporate 100,000 transistors, plus additional associated components.

This increase in the number of components in a given space or weight obviously makes possible more complex and more useful systems. In fact, such sophistication is now possible that computers with the logical reasoning capability of the human brain are in the design stage. Unfortunately, such advanced systems require a tremendous increase in the reliability of each individual component for an acceptable over-all reliability.

What this means in a specific application is shown dramatically in the requirements for the mesa-type switching transistor *Motorola Semiconductor Products Division* is producing for *Autonetics* (Div. of *North American Aviation*) in its Air Force ICBM "Minuteman" flight control system. The *Motorola* mesas must have a failure rate of 0.0007% per 1000 hours to insure adequate in-the-hole reliability for the "Minuteman" missile. This means that no failures must occur for 136 million unit-hours of testing. If one transistor were used to verify this failure rate, it must still be operable after 15,000 years.

This level of reliability is in the top bracket suggested by the Defense Department's *Ad Hoc* Study Group on Parts Specification Management for Reliability. It is apparent that such levels of reliability will come to be expected; perhaps they must even be improved upon as systems become more and more complex.

As mentioned, the transistor, because it is a solid-state device, is far more reliable by its very nature than the vacuum tube. There are no parts to wear out and nothing to break, short of crushing of the device. Thus, even prior to the demand for such reliability as that of the *Autonetics* Program, *Motorola* was producing mesa transistors with a failure rate of 0.01% per 1000 hours.

Excellent as this rate was, it was still far short of the requirement; an improvement of two orders of magnitude was needed. One effective means of designing reliability into a system is to de-rate individual devices. The operation of a transistor at 50% of its rated power obviously lessens the chances of failure of any kind. De-rating, of course, is only a start in the direction of greater reliability. The total program is much broader and far more complex.

It is interesting to compare such a program with one for improving a larger and more familiar device, say, an

A constant quality-improvement program is maintained on transistor production line producing mesa transistor for "Minuteman" missile. Note use of TV monitor at right.

airplane propeller. In the case of the propeller, the mechanical design can be changed; a thicker hub, different cross-section shape, and so on. Beyond this mechanical change, the material itself can be improved. In a somewhat similar manner, but with important differences, a transistor improvement program entails mechanical improvements and material improvements; the latter type further divided into bulk and surface defects.

Major Defects

Of the three defects causing failure—mechanical, bulk, and surface defects—the mechanical type is the major cause of catastrophic failure. Such a failure, in which the device immediately ceases to function, is caused largely by "opens" and "shorts." Fortunately, these mechanical defects are easiest to eliminate at the outset, or to find by inspection. To design-in reliability, then, the engineer might well reduce the number of connections, beef up wire sizes, and improve bonding techniques. This task is somewhat complicated by the fact that the active area of a mesa transistor can be covered by a human hair!

Having improved the microscopic mechanical design of the device as much as possible, the designer proceeds to the semiconductor material itself. Here, unwanted impurities in the ratio of several parts in a million can seriously degrade performance of new material, the properties and characteristics of which are not yet entirely understood.

Bulk defects are associated with single-crystal purity and consistency as well as the resulting resistivity values and dislocation densities. In the diffusion and evaporation processes, control of penetration or deposition must be held to a few millionths of an inch. For this reason, a semiconductor plant is an automated laboratory, with microscopes, white-coated workers, dust-free rooms, and other surgical cleanliness aspects.

Environment Control

Control of environment is an important reliability consideration in any manufacturing operation; in transistor production it assumes proportions of far greater magnitude. Dust may have little effect on even a relatively precise machining or welding operation on our hypothetical propeller, but it can ruin a *p-n* junction.

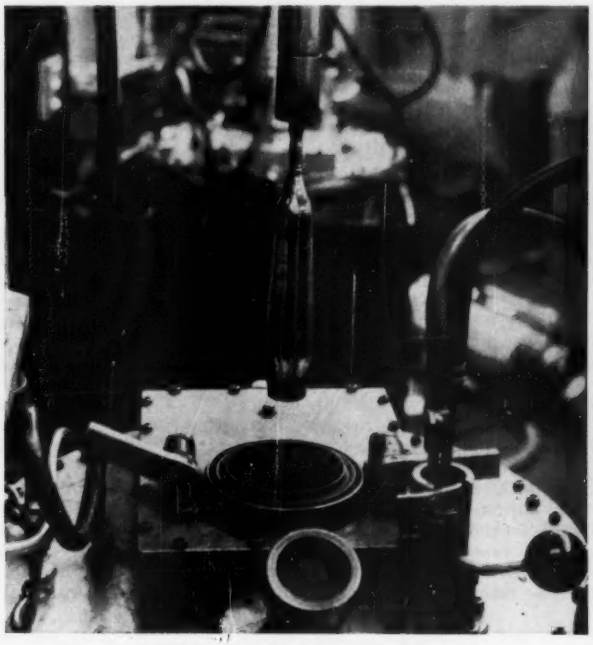
Surface defects result from contamination of the active material by oxidation, foreign materials, and so forth. These cause degradation of performance and are more insidious than the outright failure caused by mechanical defects. Moisture is another cause of such trouble. Surface passivation is the goal of the researcher in the semiconductor field, but semiconductor materials at present are still largely subject to reaction with, or contamination by, environment. Encapsulation techniques, including glass-to-metal seals, hermetic sealing, and gettering methods, are used to eliminate or minimize these harmful effects.

Repeatable accuracy in millionths of an inch demands a degree of micromanipulation not required elsewhere. Diffusion, evaporation, etching, and bonding operations make necessary new techniques and specialized equipment for cleanliness and accuracy. Dimensional quality control uses not vernier calipers and comparators, but microscope and interferometry methods, along with units like microns and angstroms.

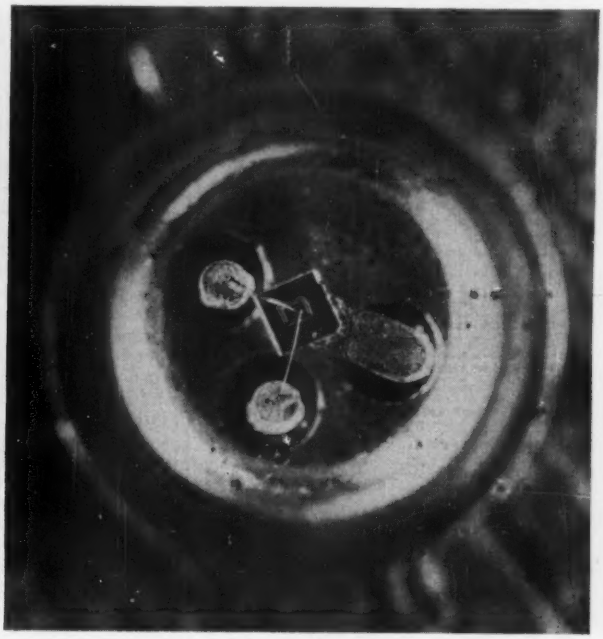
Designing and manufacturing reliability into transistor devices is a major task; proving that this reliability exists is perhaps as big and as important a job. If time were available, it would be possible to use the feedback principle of field testing and subsequent improvement. However, in the case of the "Minuteman," engineers obviously cannot wait several years to see if the missile remains combat ready. Statistical testing techniques, at a very sophisticated level, are therefore necessary to prove failure rates within the limits specified.

Three- and four-dimensional matrix tests and sequential sampling are among the methods being used in reliability testing programs. Because of the complex probability theories involved, a vast amount of test data must be fed to computers and analyzed for these techniques to be valid. In the *Autonetics* program, for instance, *Motorola* will test 65,000 devices for a total of 200 million unit-hours, much of this at accelerated rates, to prove the reliability of its mesa transistors.

The foregoing gives some idea of the problems involved in achieving high-level reliability in transistors. They are the problems of a new and very different technology, dealing with microscopic components and submolecular levels of activity in materials whose characteristics must, in some cases, be inferred. The most difficult part of the task, of course, is the level of reliability required; a level that approaches perfection. Despite these formidable barriers, the failure level of 0.0007% per 1000 hours is believed attainable. [30]



The use of high-purity single-crystal germanium is an early step in the fabrication of ultra-reliable finished transistors.



Enlarged interior of mesa transistor. Square die measures .025" and stripes to which wires are bonded are .001" x .006."

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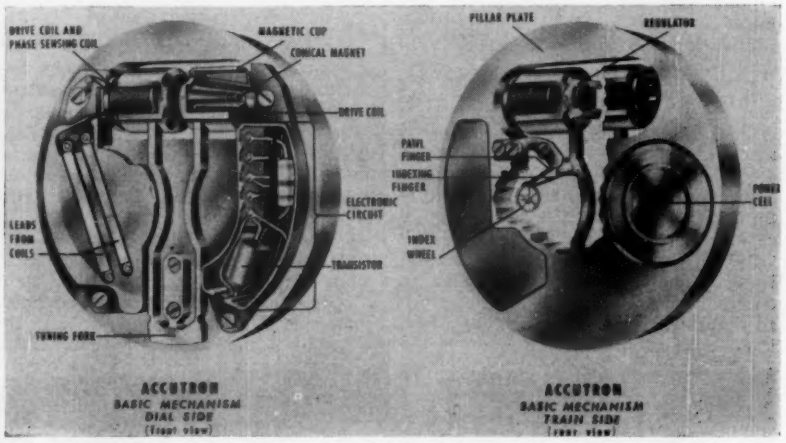


A one-inch long tuning fork, driven by a transistor oscillator, takes the place of a balance wheel and hairspring in this new electronic timepiece. Conical magnets moving in magnetic cups generate a timing signal in a coil to control oscillator.

A TICKLESS transistor-powered timepiece, called the "Accutron," has recently been introduced by the *Bulova Watch Co.* This new timepiece looks much like an ordinary wrist watch but it uses completely different principles of operation from the conventional watch. Instead of the usual balance wheel and hairspring assembly, the accuracy of the electronic watch is controlled by a miniature tuning fork in conjunction with a transistorized oscillator. The fork acts much the same way as a quartz crystal in an r.f. oscillator circuit in keeping the oscillator frequency, in this case 360 cps, highly accurate. As a matter of fact, the manufacturer considers that the "Accutron" is about ten times as accurate as a conventional fine-quality wrist watch. The new watch should be accurate to within one minute per month.

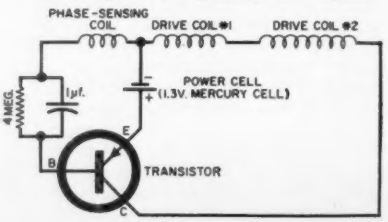
Power to operate the new watch is derived from a tiny 1.3-volt mercury cell. This cell, which costs $1.50 and is easily replaceable, will operate the watch for at least one year. Because the battery powers the watch, it is not necessary to have any winding mechanism or main spring. All in all, the electronic watch uses only 27 parts, of which only 12 are moving parts. In comparison, a typical self-winding watch uses 136 parts, of which 26 are moving parts.

The tuning fork in the new watch is approximately one inch in length, and its natural resonant frequency is 360 cps. Attached to one tine of the fork is a tiny finger-like index spring. On the tip of the index spring is a jewel that engages ratchet teeth on an index wheel. As the fork vibrates, the jewel-tipped spring moves back and forth with it, advancing the index wheel one tooth for each cycle of the tuning fork. It is the index wheel, then, rotated by the vibratory motions of the tuning fork, that turns the gear train connected to the watch's hands.

The elements that power and control the tuning fork consist of a mercury battery, transistorized oscillator or switching circuit, and a special electromagnetic assembly at the tips of the tuning fork tines. This assembly consists of a cup-like piece of magnetic iron extending outward from each tine; within each cup is a conically shaped magnet. Extending into the magnetic field of each tine is a coil of insulated wire, which is fixed and does not move. Current pulses applied to the coils cause the tines of the tuning fork to be set into motion. Also, the motion of the tines is able to induce a voltage back into the coils for control purposes. These coils are tied in with the transistor switching circuit.

The new watches are to be sold in jewelry stores throughout the country, with the price of the men's models in the $250 to $400 range. [30]

Circuit of transistor oscillator built into watch. Output operates tuning fork via drive coils. Very accurately oscillating tuning fork, in turn, generates a signal voltage that triggers the transistor circuit at the proper instants to keep the fork oscillating. Operation is much the same as a crystal oscillator with the high-"Q" tuning fork taking the place of crystal.



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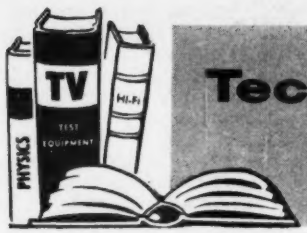

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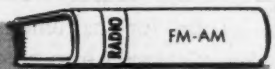

"SURPLUS RADIO CONVERSION MANUAL," William I. Orr, ed. Published by *Editors and Engineers Ltd.*, Summerland, Calif. 88 pages. Price $2.50. Soft cover.

This volume contains schematic diagrams and technical data on a number of surplus transmitters, receivers, and other units that are available and might be of interest to amateurs and experimenters.

* * *

"TRANSISTORS — CIRCUITS AND SERVICING" by B. R. A. Bettridge. Published by *Trader Publishing Co. Ltd.*, London, S.E. 1, England. 27 pages. Price 3s.4d. Soft cover.

In simple, practical terms, this compact British volume explains how transistors work, how they are used in radio circuits, and the best methods to employ when serving equipment that uses them. The treatment is almost entirely descriptive, with a scrupulous avoidance of mathematics. The technical level is suited for anyone with a fair knowledge of radio fundamentals.

* * *

"ELECTRICITY: HOW IT WORKS" by Percy Dunsheath. Published by *Thomas Y. Crowell Co.*, New York. 248 pages. Price $3.95.

Written by an eminent British engineer, this book explains simply and clearly the story of electrical energy. It covers static electricity, magnetism, current, generating electricity, transformer action, relation of light and heat, communications, and some aspects of the free electron. In addition to explanations in everyday language, the author includes some of the history of discoveries in electricity.

* * *

"101 KEY TROUBLESHOOTING WAVEFORMS FOR HORIZONTAL AFC-OSCILLATOR CIRCUITS" by Robert G. Middleton. Published by *Howard W. Sams & Co.*, Indianapolis. 128 pages. Price $2.00. Soft cover.

Here is another volume by one of television's most prolific technical writers. In this book, the author examines abnormal waveform patterns, obtained on an oscilloscope, to pin-point defects in a TV receiver. The d.c. and peak-to-peak voltage changes that are characteristic of such waveforms are also explained.

* * *

"SERVICING TRANSISTOR TV RECEIVERS" by M. S. Kiver and C. R. Gray. Published by *Howard W. Sams & Co.*, Indianapolis. 269 pages. Price $4.50. Soft cover.

This is a practical guide to the use of transistors in modern TV receivers. The first two chapters introduce transistors and their basic circuits; the rest of the book (eight chapters) discusses TV circuits using transistors, how they operate, and how to troubleshoot and repair them.

* * *

"EXPERIMENTS IN INDUSTRIAL ELECTRONICS" by Melvin Whitmer. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 94 pages. Price $1.95. Soft cover.

Written to fill the gap between entertainment and industrial electronics, this book contains a series of do-it-yourself construction projects for the technician dealing with units that resemble commercial equipment used in the field. Included are photoelectric controls, timers, electronic heating circuits, measurement transducers, proximity detectors, d.c. motor controls, and servo systems.

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"INSTALLING HI FI SYSTEMS" by Jeff Markel & Jay Stanton. Published by *Gernsback Library, Inc.*, New York. 224 pages. Price $3.20. Soft cover.

Steps to take before starting a hi-fi installation, to assure best results, are explained and illustrated in this popularly written volume. Of interest to both the audio fan and the professional specialist, the book discusses various types of mono and stereo systems, with emphasis on the electrical, physical, and esthetic relationships between components. Some material on setting up a system to meet a person's specific needs also is included.

* * *

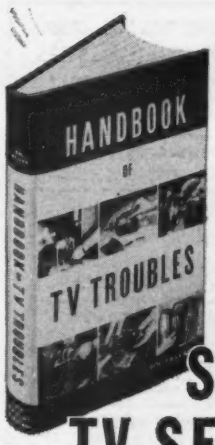
"VIDEO TAPE RECORDING" by Julian Bernstein. Published by *John F. Rider Publisher, Inc.*, New York. 272 pages. Price $8.95.

Readers professionally concerned with this field will find this book extremely useful. It covers the theory and circuitry of all existing video tape equipment, and explains the advantages, characteristics, and limitations of the new medium. The text may be followed readily by anyone with even a limited technical background.

* * *

"ANALYSIS AND DESIGN OF FEEDBACK CONTROL SYSTEMS" by George J. Thaler and Robert G. Brown. Published by *McGraw-Hill Book Co., Inc.*, New York. 648 pages. Price $14.50.

Formerly entitled "Servomechanism Analysis," this book is a complete revision of the earlier text. Both the material and its presentation have been brought up to date. Designed for a first course in feedback control system theory, the text is pitched on a senior-graduate level, leaning heavily on advanced math. [30]



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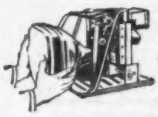

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Tape for Instrumentation

(*Continued from page 64*)

sensing arrangements that continually monitor tape tension and servo the supply and take-up motors accordingly to provide uniform tension under all modes of operation. One way of monitoring tape tension is to sense the pressure behind the magnetic tape running over an air-lubricated tape guide. In operation, the tape is centered and lifted off the surface of the guide by means of an air film. Fig. 8 is a block diagram of a system having separate air pressure tension sensing for both supply and take-up motors.

Servo Speed Control. Except for applications requiring synchronization of magnetic tape-recorded sound tracks with motion pictures, audio recorders are completely satisfactory if they provide $\pm 0.2\%$ long-term timing accuracy. This is quite good enough for split-second radio broadcast scheduling but such accuracies are often unsatisfactory in many instrumentation applications. Moreover, tape stretch or slippage and recorded speed errors must often be compensated for upon playback. Figs. 9 and 10 are block diagrams of typical record and reproduce servo systems, respectively. During recording, a reference frequency is recorded on the tape and every effort is made to insure uniform speed by powering the synchronous capstan drive motor from an amplified frequency standard. Upon playback, this reproduced reference frequency is compared in phase with a suitable reference and the error used to correct the speed of the capstan motor. Time displacement errors of less than ± 0.25 millisecond at a tape speed of 60 ips are obtained with such systems.

These, then, are the principal areas of variation in magnetic tape recorders. While the art was evolving, it was the usual practice for tape equipment manufacturers to custom design and produce a succession of special recorders for a particular application. While simpler from a service and maintenance standpoint, this limited the machine to certain performance capabilities and made it difficult to adapt to different recording procedures or system expansion. Today, general-purpose laboratory recorders are available which can handle not only different recording methods and tape speeds, but can be adapted to later system expansion. An understanding of the differences is, therefore, becoming of increasing importance.

Industrial Uses

Few devices have been accepted as readily as the tape recorder which, in twelve years, has spread in all directions until now it is a basic tool for advanced scientific activities, contributing heavily to research and military programs, missile development, satellite tracking, and related instrumentation laboratory procedures.

In industrial plants, it is being used for both machine-tool and process control:

Machine-tool control: For most machine-tool applications, the signal on the tape is derived from the output of a machine under the control of a skilled operator actually making the part.

On playback, the recording will then be able to recreate the original movements of the machine tool and turn out a duplicate of the original part. A more advanced approach is the use of a computer to prepare the tape without the machinist performing the original operation. Starting with a blueprint, it is possible to extract sufficient information defining the surfaces of the contours to be generated. This information can be fed into a computer. The computer can translate this information into the correct electrical signals which will then control the various motions of the machine tool and generate the part. It is

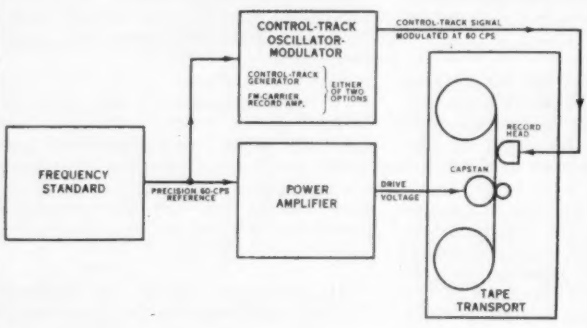

Fig. 9. Over-all simplified system block diagram illustrating a typical record servo system. Refer to text.

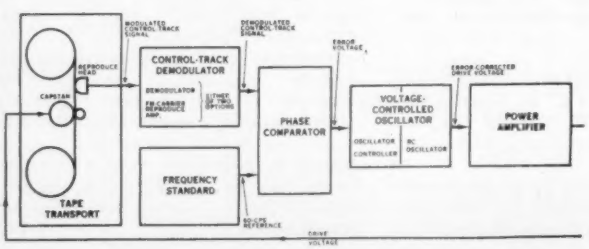

Fig. 10. Simplified system block diagram showing a typical reproduce servo system.

this output-signal information which can be recorded on a multi-track magnetic tape and re-used as many times as desired to turn out quantities of the part.

Process control: Electrical signals from magnetic tape can operate valves, pressure controls, motors, speed controls, or any other desired mechanical or electrical responses. In this way, tape signals in a process sequence can repeat any pattern of temperatures, pressures, agitations, timed feeding of ingredients, etc., that will achieve a successful result. Thus, in chemical, metallurgical, manufacturing, and similar fields, it is possible to provide precise control over timing and perfect synchronization of all variables.

Magnetic tape memory can also be used to make a delayed correction in flowing or cycling processes. It can pick up a measurement at one point—be timed exactly with the steady process flow or cycle—then apply a correction at another point some definite time interval later in the process.

Future Applications

Despite its demonstrated history of dependable and economical performance as a memory device, tape is still a radically new storage concept in some industrial areas—and the first magnetic tape recorder that is purchased by an industrial plant should be planned for—and *cared for*—properly. A tape-controlled machine is more than just another piece of equipment. It can hit a plant with a heavy impact—but it has been proven that this impact can push the plant ahead. For, wherever high information capacity, high orders of accuracy, and storage and reproduction of many simultaneous variables are required, magnetic tape offers distinct advantages. Punched cards and punched paper tape cannot approach the speed of magnetic tape in transfer of information; magnetic core memories and electron tube storage or display devices, while faster in transfer than magnetic tape, cannot approach the storage capacity of magnetic tape on any economic basis by several orders of magnitude. The future is sure to hold an increasing use of automatic machine tools, controls, and processes—with magnetic tape actively involved in such progress.

[30]

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(*Continued from page 60*)

separate locations. About one-third of these are in school systems of less than 2000 pupils which, for the most part, are too small to provide satisfactory education under present conditions. Now through MPATI children in these small schools can be taught by the best teachers in the nation."

"You're pretty steamed about this thing, aren't you?" Mac asked quizzically.

"Yes, I am," Barney admitted. "As you know, I'd have gone to college if Dad had lived; and I've never got over wanting more education. What you've taught me about electronics has helped a lot, but I'd still like to know more about math and science. I'm hoping that when these courses are being telecast, I can sort of keep an eye on the screen while I'm working here at the bench and maybe pick up some things that will help."

"That will be fine with me," Mac said quickly; "and I'll watch along with you. Maybe it's still not too late for an old dog to learn a new trick or two. But how about reception of these programs? Does the MPATI take care of that, too?"

"Only to the extent of offering advice. Each participating school is to install its own receiving equipment. MPATI suggest that 20 to 30 students be permitted to watch one receiver. This receiver, which should have at least a 21″ screen, should be mounted so that the center of the screen is 5½ feet from the floor on a stand of aluminum tubing. If necessary, the stand can be on rollers. It is suggested the receiver be of good quality and be purchased from a reputable firm. I was interested to read the statement that such a receiver could be expected to give good service for at least 3 to 5 years or more *with regular maintenance.*"

"How about antennas, distribution systems, and so on?"

"The cost of the antenna goes up as the distance from the plane increases. For example, the cost of an installed antenna up to 50 miles from the plane is estimated at $50-$100; from 50-100 miles, $100-$200; from 100-150 miles, $200-$1000. A very small school might get by with separate antennas attached directly to separate receivers; but it would be more economical for a larger school to employ a single antenna working into u.h.f.-to-v.h.f. converters, then into amplifiers, and through a distribution system to the sets in the classrooms. An advantage of the latter system is that it lends itself very handily to the use of closed-circuit TV at some later date."

"I see you've been thinking about this thing as a source of future business as well as a possible answer to the problem of how to get better education without imposing confiscatory taxes."

"I plead guilty. This whole project is a sort of pilot program. If it works out as well as expected, it may reveal a real break-through in providing better education at lower cost. In that event, a few planes flying in the stratosphere will soon be blanketing the entire United States with first-class instruction. Evening courses could be provided for people not able to attend college and for advanced students. The possibilities are breath-takingly exciting.

"But looking at the program from the point of view of a hard-headed TV technician is almost as awe-inspiring. This might easily be the beginning of a whole new source of lucrative business. Those antennas must be erected; the head-end equipment of converters and amplifiers must be installed and maintained; distribution systems must be laid out; and the receivers must be sold, installed, and maintained. When you think of all the schools in the country, plus the private individuals who will want to watch the telecasts, this adds up to a staggering amount of business. We're mighty lucky to be sitting right here on the ground floor of the experiment, and I certainly intend to keep my eyes on it, both to learn more math and perhaps to get more business for us."

"That's my boy!" Mac said fondly. "I'm with you one hundred per-cent on both counts, although I must admit the whole thing sounds like a lot of *pi* in the sky to me!" [30]

SIMPLE LOUDNESS CONTROL

By GEORGE D. CURTIS

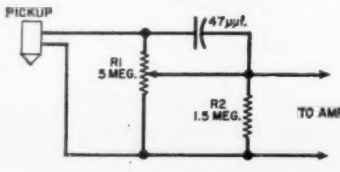
THE increasing popularity of both stereo and mono phonographs has indicated the need for an inexpensive loudness control. This is easily obtained with ceramic and crystal cartridges by taking advantage of the fact that their bass response increases with load.

A high-resistance pot, R_1, is used at the input, connected as shown in the diagram, to increase input impedance as loudness is reduced. Most present cartridges are equalized for the RIAA curve when loaded with from .5 to 2 megohms. The value of R_1 is chosen to be much greater than the manufacturer's recommended load and will commonly be 2 to 10 megohms.

R_2 is chosen to provide a flat response load at high loudness levels and will average 1 to 1.5 megohms. R_2 can also be made variable so that it can be used as a level-set control.

A capacitor adds treble boost called for in the Fletcher-Munson curves. It is typically 47 $\mu\mu$f., but is often omitted since treble boost is considered unnecessary by many.

Values the author used with a Sonotone 3TS cartridge are shown in the diagram. [30]



Sound on Tape

By **BERT WHYTE**

AS reported elsewhere in this issue, the New York Hi-Fi Show was early this year hence a chance to bring you a report in time for your Christmas shopping. What is new in the tape world? Not too much, really.

As with a great deal of other hi-fi gear, this is more a time of revision and refinement rather than innovation. Oh, there were several new models, but they didn't include anything startling. One thing seems to have been accepted and was sort of the dominant theme among the tape machine manufacturers and that was that the reel-to-reel, four-track concept is now solidly entrenched. For the time being at least, the tape cartridges are in eclipse. This is all to the good at present, resulting in quite a show of strength from the manufacturers who have been emboldened to bring out more tape machine models than in the last three years.

American Concertone brought out a unit that will have a lot of appeal for the more professionally inclined home recordist. It features special purposes and, most important, accepts the 10½-inch reels. *Ampex* was showing many new versions of its big "packaged" stereo tape systems but of more practical news to the recordist is that the Model 960 has been reduced in price by some $125.00. For the really serious tape hobbyist, *Ampex* has brought out what is essentially its older 351-2 stereo recorder, but in order to save space and also knock down the price, the dual electronics have now been integrated and combined on one chassis. Thus a professional quality recorder can be contained in just two cases.

Bogen-Presto was demonstrating its big unit which appears to have undergone some face-lifting and received some mechanical and electrical refinements. *Crown International* has slowly been gaining stature and size in the tape recorder field and showed its excellent "Crown Prince" model, which at the price and for its professional features should beget many sales. For the recordist who wants a really long-playing unit, *Crown* is prepared to offer a machine which can handle 14-inch reels! *Norelco* has a four-track stereo record version of its popular Dutch-made machine, which was attractively styled. *Roberts Electronics* showed an improved version of its stereo unit which was introduced last year. The firm has also ventured into the field of complete stereo tape consoles.

The *Sony* people evoked a lot of interest with the new lower prices on some of their previous models and the promised introduction of a completely transistorized recorder. I understand there was a prototype about, but I didn't get to see it and, in any case, production is supposed to be some time off yet.

Tandberg is coming along at a great rate and is now in the console business too. These Norwegian-made recorders have built up a fine reputation over the past three years and with the refinements incorporated in the current models should do well in sales. *Telectro-Sonic,* which has done a great deal of tape machine manufacturing for the government, had a number of attractive new tape decks which can run directly into tape-head inputs of preamps so equipped, as well as complete tape units with integral preamps.

All of the raw tape companies were there—including *Audio Devices* and *Reeves Soundcraft*—nothing much new except reduced prices on some Mylar-base material and a big exhibit of pre-recorded, four-track tapes from *Ampexes UST* subsidiary. To many folks' dismay, several of the low-priced condenser mikes which were supposed to appear, are still in the dream stage.

So that was about it—a firming up of reel-to-reel four-track business, but no sensational disclosures. However, it was worth noting that many people in the business feel that this is going to be a banner year for tape and, cartridge or no cartridge, this will be remembered as the year in which tape was, for once and for all, established as an important musical medium.

BERLIOZ
SYMPHONIE FANTASTIQUE
Paris Conservatoire Orchestra conducted by Ataulfo Argenta. London Stereo LCL80012. Price $7.95.

This is the by-now-famous performance by the late Argenta. It is not the "Fantastique" preferred by most, but it is certainly a new view of the score as taken at very fast tempi. The drive and vigor here is terrific and almost exhausting in the final movements.

Argenta has the advantage of very good sound here, clean for the most part, except in the last moments when some overload can be detected. All the stereo attributes are evident . . . good direction, nice center fill, well proportioned depth, and good acoustics.

Hi-fi addicts can have a ball with the tympani and cymbals and bell in the last movements . . . they are played lustily and with abandon.

BASIE/ECKSTINE, INC.
Count Basie and Billie Eckstine. Roulette Stereo RTC507. Price $7.95.

If you like these performers, you'll get a boot out of this recording. If you don't, stay away as there is a lot of each on this tape.

My own feeling is that Basie and Eckstine make a fine combo and do a very respectable job on all of the numbers but that it isn't the sort of thing you can listen to, tune after tune.

Billy is great in things like "Stormy Monday Blues" and "Jelly Jelly" and others in the album and he gets appropriate and sympathetic accompaniment from the Count. The sound, in general, is good, with Eckstine occupying center fill and with directivity a bit overdone on the orchestra. My only quibble is the occasional overload encountered when Billie gets too far inside the mike.

LALO
SYMPHONIE ESPAGNOLE
Ruggiero Ricci, violinist, with L'Orchestre de la Suisse Romande conducted by Ernest Ansermet.

SIBELIUS
CONCERTO FOR VIOLIN AND ORCHESTRA
Ruggiero Ricci, violinist, with London Symphony Orchestra conducted by Oivin Fjelstad. London Stereo "Twin-Pak" LCK80046. Price $11.95.

Two of the staples of the violin repertoire are neatly paired here and played, if not definitively by Ricci, at least with a respect for the score, a smooth polished technique, and a good measure of fire and spirit.

The comparison between the two orchestras is interesting, by the way, the superior London woodwinds nodding in respect to the richer strings of the Suisse Romande. The sound in both recordings is quite good, with the engineering in the Lalo a little better than in the Sibelius. Stereo depth is readily apparent in both, as well as a good show of directivity.

The Ricci tone sounds much the same in both except that he is closer miked in the Lalo and thus gains a bit more presence. Both recordings could have been a shade more detailed for my taste, as in some of the *tuttis* things get a little lost.

BRUCKNER
SYMPHONY #7
Orchestra of the Sudwest Rundfunk, Baden, conducted by Hans Rosbaud. SMS Stereo S11. Price $8.95.

Bruckner is not for everyone, but if you like his music you will find this monumental symphony gets a superb performance from a great Bruckner man, Hans Rosbaud.

Unfortunately, the orchestra is not up to the standards Rosbaud wants and the sound is dullish, compressed—not acoustically but in dynamic compass—and the tape hiss is too high. Too bad there isn't some way of correcting this deficiency. [30]

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Vertical Test Transformer

(*Continued from page* 52)

transformer as used in the particular circuit can be read from the graph.

There is more than one way of finding out whether this value is satisfactory. The simplest is by referring to standard reference material. The set manufacturer's part number for the original unit can be found in the service data. A good TV transformer replacement guide will give the turns ratio, primary impedance, and d.c. current rating for the recommended replacement.

Actually, impedance matching is seldom a problem. To begin with, most sets are designed so that there is a wide allowable tolerance in this respect. Thus an approximate rather than an exact match should be satisfactory to begin with. In addition, no harm will be done if the primary impedance is higher than that of the original transformer; a problem may exist only when the impedance of the replacement is too low. As a result, this is the way things work out in practice: when the primaries of the VO-109 are connected in series, impedance has always been satisfactory. With parallel primaries, there are a few cases where impedance will be too low.

Aside from the circuit check by substitution, the multi-ratio unit comes in handy when it has already been decided that the original transformer is defective but there is insufficient data for determining the exact replacement. This will not be true with most sets, but there are some private-label brands, discontinued brands, or older models on which adequate data is not available. Experimentation with the universal unit in the circuit can reveal the characteristics that must be known. Where the characteristics are known but a standard replacement is not available, the VO-109 can do the job itself.

A similar problem can occur even when the data on the original is completely accessible. Some TV sets are designed to minimum standards. In the vertical circuit, this means that full deflection may be obtainable when the receiver is brand new or under ideal operating conditions. However, as components age or when low line voltage is encountered, it may be impossible to get full picture height no matter how one adjusts the vertical controls. This may be due to the cumulative effect of slight changes in several circuit components, none of which can be considered as truly defective. Thus a restoration of full deflection could be achieved, not by replacing one component, but by wholesale changes. The most sensible solution may be a transformer with a different turns ratio that will make adjustment for proper deflection less critical. The VO-109 can be used in such cases to decide on the requirements for the replacement, or to act as a flexible replacement in a circuit that may require future change. [30]

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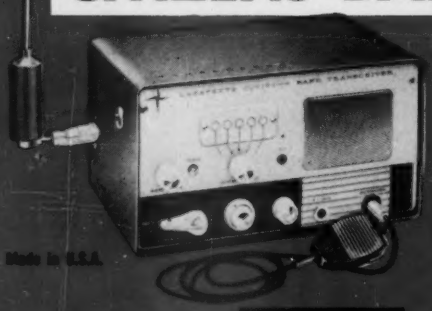

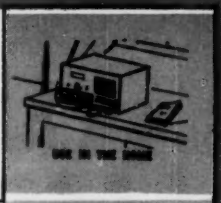

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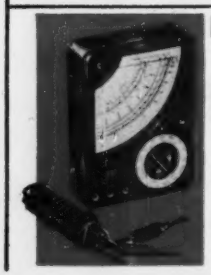

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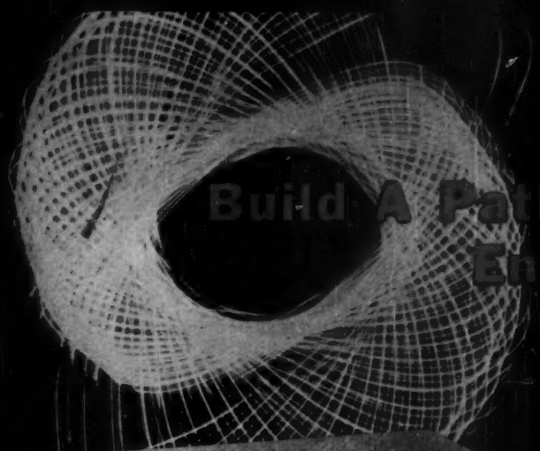

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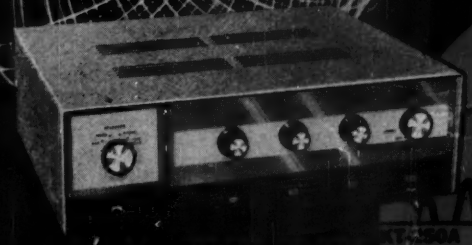

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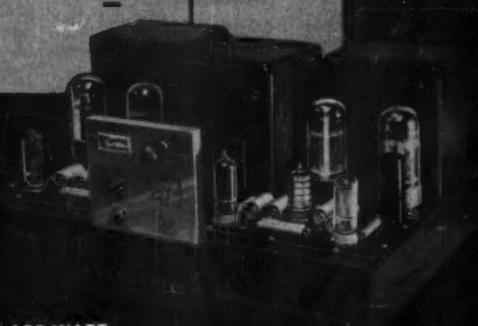

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INVITATION TO AUTHORS

Just as a reminder, the Editors of ELECTRONICS WORLD are always interested in obtaining outstanding manuscripts, for publication in this magazine, covering the fields of audio and high-fidelity and radio-TV-industrial servicing. Articles in manuscript form may be submitted for immediate decision and projected articles can be outlined in a letter in which case the writer will be advised promptly as to the suitability of the topic. We can also use short "filler" items outlining worthwhile shortcuts that have made your servicing chores easier. This magazine pays for articles on acceptance. Send all manuscripts or your letters of suggestion to the Editor, ELECTRONICS WORLD, One Park Avenue, New York 16, New York.

Determine Your Income

(*Continued from page 49*)

$1700 represented by inventory on hand. This $2900 is important because, if it were not tied up in this way, it could have been used for other purposes.

If it did nothing more than sit in a savings account, it would have accumulated interest. However, Joe has a modest amount aside from this in such an account to cover emergencies. If the $2900 were available, he would therefore have taken it to an investment counselor, as other acquaintances of his had done. Not being a speculator with illusions of getting rich quick on risky ventures, he would have put this money into conservative dividend-yielding or interest-bearing securities — securities that are far less risky than his attempt to build up his own shop. Since these could reasonably be expected to yield 5 per-cent, he could have earned $72.50 in the past six months without getting out of bed.

Joe deducted this $72.50 from his $1200 net income, since the investment in the shop was actually depriving him of the former amount, and legitimately decided that his true net income was $1127.50. Since he had put about 500 hours of time into his shop in the past six months, to earn the latter amount, he was earning $2.25 an hour. Even if he hadn't deducted the investment income he could have had, his hourly rate would have been only $2.40—and he has not made any allowance for re-investing some portion of his net income in the business to help it grow.

At this juncture, Joe turned a little green. Electing to stick to his business, he had just turned down a part-time job that would have paid $2.75 an hour. To make matters worse, this factory position was far easier than tackling the string of intermittents and dogs he had been running into lately. Nevertheless, he liked being his own boss, was doing the work he enjoyed best, and felt that he still had a better chance for improving in his own business than he would if he worked for someone else.

At this point, the Income Statement has done its most important job because, by putting things into perspective, it has shocked the shop owner into seeing exactly where he stands. However, it can do even more. Joe can use it to evaluate steps he might take to improve his plight.

The remedial measures themselves need not be new or startling. He might try to sell more radio and TV sets by pushing sales actively instead of waiting for customers to come to him. He might take on hi-fi merchandise or Citizens Band units, which he hasn't handled until now. His service methods in and out of the shop can be reviewed to see whether he can organize them more efficiently so that he can make more calls in the same time. He should probably increase his fees. Operating expenses might be reviewed to see whether cuts can be made. Purchasing practice may be improved if he has not been taking advantage of all discounts and allowances he can get through quantity buying or prompter payment. Whatever changes he attempts, his Income Statement helps him judge how they might affect his hourly income.

He decides that, with a little more push, he could have sold three more TV sets, three more radios, and a hi-fi system during the past six months to increase his net income by $160. A modest increase in his fee for a house call would have produced an additional $150. By displaying such small items as batteries, interference filters, indoor antennas, and other accessories to better advantage—or by adding items of this sort that he didn't carry before—he might increase over-the-counter sales by $13. The total hypothetical increase comes to $323. Adding this to his actual income, Joe decides that he could have made $1450.50 during the statement period. This would have come to $2.90 per hour.

While the final set of calculations was theoretical, it shows how the Income Statement may be used to plan improvement, aside from letting you know where you now stand. In the case of Joe Smith, he was able to decide that a continued effort was worthwhile. With a little more concentration in specified directions, he has a chance of improving his income to a respectable level and moving closer to full-time operation at a realistic rate.

He is now in a position to compare actual results shown on his next statement, which will take him to the end of 1960, with the statement in Table 1. He can also compare the next statement with the hypothetical changes he has made to the present one. This will tell him how well his attempts at improvement are succeeding, what approaches he should change, and whether he has indeed justified the decision to keep the shop going. All this would be impossible without the comparatively simple record under discussion.

It must be stressed that maintenance of an Income Statement does not preclude the need for other bookkeeping procedures and statements. This fact will probably become clear if you attempt to round up the data you need for your first Income Statement. In fact, such an attempt may clarify the need for other, systematic records if there has been negligence in such matters. For example, no mention has been made in this article of such familiar items as debits and credits.

A single statement cannot replace a good set of business records or the services of a competent accountant. These will be necessary in any case. However, it is no secret that a large number of service shops are far too careless about records in general. The preparation of an Income Statement is something that the shop owner can handle himself, aside from other records. The understanding of his situation with which it provides him should spur him on to take the other steps necessary to get his records in order. [30]

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	0Z4M	.79		3DT6	.50		6AB4	.46		6BJ6	.62		6EU8	.79		12A4	.60		12BD6	.50		12EG6	.54		19BG6	1.39
	1AX2	.62		3Q5	.80		6AC7	.96		6BK7	.85		6EA8	.79		12AB5	.55		12BE6	.53		12EZ6	.53		19T8	.80
	1B3GT	.79		3S4	.61		6AF3	.73		6BL7	1.00		6H6GT	.58		12AC6	.49		12BF6	.44		12F5	.66		21EX6	1.49
	1DN5	.55		3V4	.58		6AF4	.97		6BN4	.57		6J5GT	.51		12AD6	.57		12BH7	.73		12F8	.66		25BQ6	1.11
	1G3	.73		4BC5	.56		6AG5	.65		6BN6	.74		6J6	.67		12AE6	.43		12BL6	.56		12FM6	.45		25C5	.53
	1J3	.73		4BC8	.96		6AH6	.99		6BQ5	.65		6K6	.63		12AF3	.73		12BQ6	1.06		12K5	.65		25CA5	.59
	1K3	.73		4BN6	.75		6AK5	.95		6BQ6GT	1.05		6S4	.48		12AF6	.49		12BY7	.74		12SA7M	.86		25CD6	1.44
	1L6	1.05		4BQ7	.96		6AL5	.47		6BQ7	.95		6SA7GT	.76		12AJ6	.46		12BZ7	.75		12SK7GT	.74		25CU6	1.11
	1LN5	.59		4BS8	.98		6AM8	.78		6BR8	.78		6SK7	.74		12AL5	.45		12C5	.56		12SN7	.67		25DN6	1.42
	1R5	.62		4BU8	.71		6AN4	.95		6BU8	.70		6SL7	.80		12AL8	.95		12CA5	.59		12SQ7M	.73		25EH5	.55
	1S5	.51		4BZ6	.58		6AN8	.85		6BY6	.54		6SN7	.65		12AQ5	.52		12CN5	.56		12U7	.62		25L6	.57
	1T4	.58		4BZ7	.96		6AQ5	.50		6BZ6	.54		6SQ7	.73		12AT6	.43		12CR6	.54		12V6GT	.53		25W4	.68
	1U4	.57		4CS6	.61		6AR5	.55		6BZ7	.97		6T4	.99		12AT7	.76		12CU5	.58		12W6	.69		25Z6	.66
	1U5	.50		4DE6	.62		6AS5	.60		6C4	.43		6U8	.78		12AU6	.50		12CU6	1.06		12X4	.38		35C5	.51
	1X2B	.82		4DK6	.60		6AT6	.43		6CB6	.54		6V6GT	.54		12AU7	.60		12CX6	.54		17AX4	.67		35L6	.57
	2AF4	.96		4DT6	.55		6AT8	.79		6CD6	1.42		6W4	.57		12AV5	.97		12DB5	.69		17BQ6	1.09		35W4	.52
				5AM8	.79		6AU4	.82		6CF6	.64		6W6	.69		12AV6	.41		12DE8	.75		17C5	.58		35Z5GT	.60
	3AL5	.42		5AN8	.86		6AU6	.50		6CG7	.60		6X4	.39		12AV7	.75		12DL8	.85		17CA5	.62		50B5	.60
	3AU6	.51		5AQ5	.52		6AU7	.61		6CG8	.77		6X5GT	.53		12AX4	.67		12DM7	.67		17D4	.69		50C5	.53
	3AV6	.41		5AT8	.80		6AU8	.87		6CM7	.66		6X8	.77		12AX7	.63		12DQ6	1.04		17DQ6	1.06		50DC4	.37
	3BA6	.51		5BK7A	.82		6AV6	.40		6CN7	.65		7AU7	.61		12AZ7	.86		12DS7	.79		17L6	.58		50EH5	.55
	3BC5	.54		5BQ7	.97		6AW8	.89		6CR6	.51		7A8	.68		12B4	.63		12DZ6	.56		17W6	.70		50L6	.61
	3BE6	.52		5BR8	.79		6AX4	.65		6CS6	.57		7B6	.69		12BA6	.50		12EL6	.50		19AU4	.83		117Z3	.61
	3BN6	.76		5CG8	.76		6AX7	.64		6CU5	.58		7Y4	.69												
	3BU8	.78		5CL8	.76		6BA6	.49		6CU6	1.08		8AU8	.83												
	3BY6	.55		5EA8	.80		6BC5	.54		6CY5	.70		8AW8	.93												
	3BZ6	.55		5EU8	.80		6BC7	.94		6CY7	.71		8BQ5	.60												
	3CB6	.54		5J6	.68		6BC8	.97		6DA4	.68		8CG7	.62												
	3CF6	.60		5T8	.81		6BD6	.58		6DB5	.69		8CM7	.68												
	3CS6	.52		5U4	.60		6BE6	.55		6DE6	.58		8CN7	.97												
	3CY5	.71		5U8	.81		6BF8	.44		6DG6	.59		8CX8	.93												
	3DK6	.60		5V6	.56		6BG6	1.66		6DQ6	1.10		8EB8	.94												
				5X8	.78		6BH6	.65		6DT5	.66		10DA7	.71												
				5Y3	.46		6BH8	.87		6DT6	.53		11CY7	.75												

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EW-1260

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

Model TW-11—TUBE TESTER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months if satisfactory. Otherwise return, no explanation necessary!

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Subminiatures, Novals, Subminars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

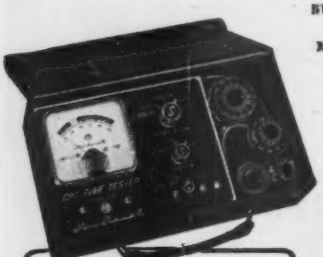
SEPARATE SCALE FOR LOW-CURRENT TUBES: Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a handsome, portable Saddle-Stitched Texon Case. Only..... $47.50

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

TESTS AND REJUVENATES ALL PICTURE TUBES



Model 83—C.R.T. Tube Tester
Total Price $38.50
Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types —from 8" to 30" types.

- Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

ALL COLOR TUBES

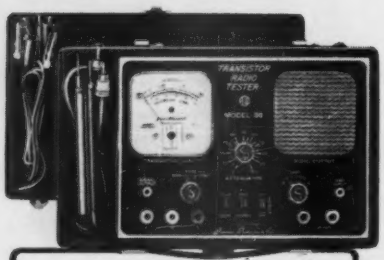
Test ALL picture tubes—in the carton—out of the carton—in the set!

- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only..... $38.50

The Model 88 . . . . A New Combination

TRANSISTOR RADIO TESTER and DYNAMIC TRANSISTOR TESTER



Model 88 — Transistor Radio Tester and Dynamic Transistor Tester. Total Price . . . $38.50 — Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

The Model 88 is perhaps as important a development as was the invention of the transistor itself, for during the past 5 years, millions of transistor radios and other transistor operated devices have been imported and produced in this country with no *adequate* provision for servicing this ever increasing output.

The Model 88 was designed specifically to test all transistors, transistor radios, transistor recorders, and other transistor devices *under dynamic conditions.*

AS A TRANSISTOR TESTER

The Model 88 will test all transistors including NPN and PNP, silicon, germanium and the new gallium arsinide types, **without referring to charactistic data sheets.** The time-saving advantage of this technique is self evident. A further benefit of this service is that it will enable you to test new transistors as they are released! The model 88 will measure the two most important transistor characteristics needed for transistor servicing; leakage and gain (beta).

AS A TRANSISTOR RADIO TESTER

The Model 88 provides a new simplified rapid procedure — a technique developed specifically for transistor radios and other transistor devices.

An R.F. Signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble whether it be a transistor, some other component or even a break in the printed circuit is located and pin-pointed.

Only..... $38.50

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-On Cables for Transistor Testing, an R.F. Diode Probe for R.F. and I.F. tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete—nothing else to buy!

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7 Signal Generators in One!

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✓ R.F. Signal Generator for F.M. ✓ Cross Hatch Generator
✓ Audio Frequency Generator ✓ Color Dot Pattern Generator
✓ Marker Generator

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

Model TV-50A—Genometer
Total Price $47.50
Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 80 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peak wave audio signal.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

$47.50 NET

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV): Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency)

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Model 77 — VACUUM TUBE VOLTMETER ... Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price

- ✓ Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- ✓ Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- ✓ Model 77 uses new improved SICO printed circuitry.
- ✓ Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.
- ✓ Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- ✓ Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- ✓ Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER: Measures RMS values of sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

SPECIFICATIONS

• **DC VOLTS**—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak)—0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER**—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms • **DECIBELS** —10 db to + 18 db, + 10 db to + 38 db + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

$42.50 NET

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only.....

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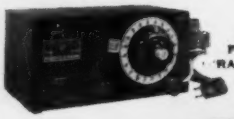

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Hi-Fi Record Changers

(Continued from page 44)

may jam the change mechanism but even if they don't they may not be reproduced well. Records with off-center or badly reamed center holes will sometimes stick on the spindle. While the raised rims of certain brands of records prevent the recorded sections of stacked discs from rubbing against each other, there is often not enough traction between such records to prevent slippage. Bits of masking tape attached to the labels of such records will correct this situation. If the stylus pressure or point at which the stylus is set down at the beginning of a record are not correct, such faults may usually be corrected by simple adjustments indicated in the record changer's installation or operation instruction booklet.

One disadvantage of a changer is that its many convenience features are more or less negated when symphonic LP's are being played. In such cases, the changer must be operated as a manual turntable in order to play both sides of the recording—but changers are still handy for those occasions where hours of uninterrupted background music are the order of the day.

The modern record changer is a precise, ingenious instrument, designed and manufactured to perform an amazing number of functions and marketed at a remarkably low price. It can be made to be qualitatively compatible with most high-fidelity systems. Some changers may have shortcomings, true, but they possess virtues that compensate for these shortcomings. It is these virtues of convenience, dependability, and economy that have made the record changer popular and this very popularity has played a major role in increasing the audience for fine recordings. [30]

TWIN-LEAD TOOL HOLDER

By RONALD M. HENRIKSON

PROVIDING easy access to tools is an age-old problem, which has never been completely solved. Many people use pegboards, various types of racks and metal holders, etc. The method to be suggested by the author costs next to nothing.

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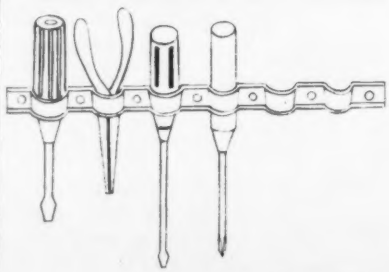

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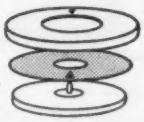

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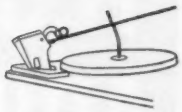

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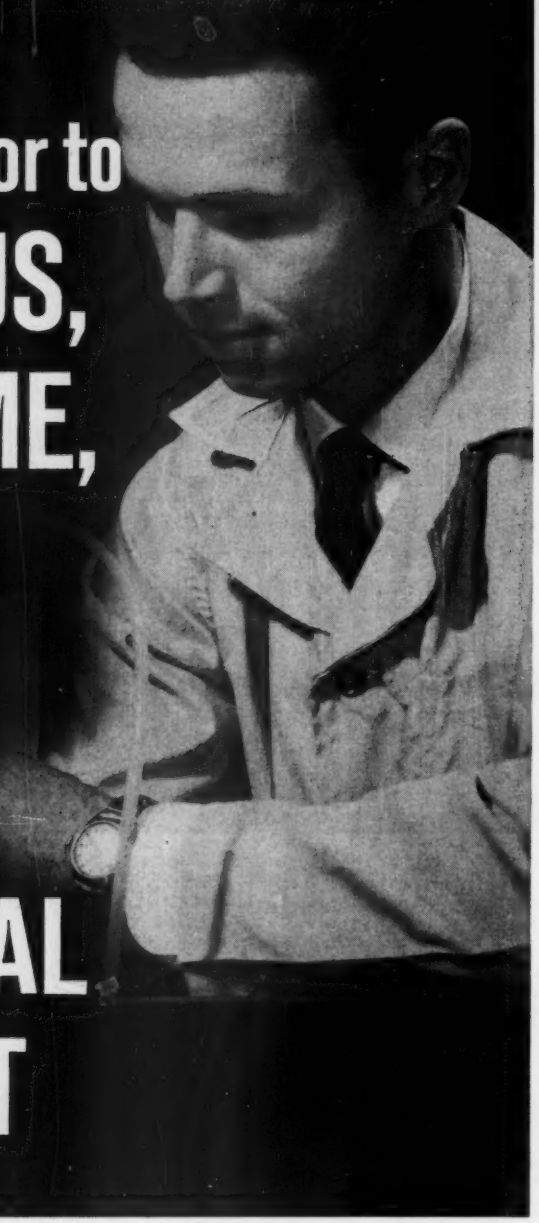

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CERTIFIED RECORD REVUE

By **BERT WHYTE**

THE report I promised you on the new and unusual at the New York Hi-Fi show turned out to be so extensive that it appears elsewhere in this issue and this column will concentrate on the reviews of discs at hand.

Recordwise things are beginning to pick up and while many of the big discs are still in the offing, there are some choice items currently available. Permit me once again to thank you all for your support during the past year and may I wish you and yours a very Merry Christmas and a Happy and Prosperous New Year!

DVORAK
REQUIEM (Op. 89)
Maria Stader, soprano; Sieglinde Wagner, alto; Ernest Haefliger, tenor; Kim Borg, bass, with Czech Philharmonic, Prague, conducted by Karel Ancerl. DGG Stereo 138026/7. Price $11.90. Two discs.

Yes, this is correct . . . a "Requiem" by Dvorak! Very rarely performed in this country, it has been largely overshadowed by the more familiar Berlioz and Verdi works, which is a pity because this is a very fine work, with many sections of outstanding beauty. It is not as florid and dynamic as the Berlioz and Verdi scores, but it is not lacking in spirit and vigor. There are many sections which have considerable fervor.

The performance seems authentic as it should considering the forces employed. In general, this has fine sound. The stereo directivity is once again more than is usual with the M/S stereo technique. I was recently told by a *Deutsche Grammophon* official that the technique was deliberately modified for more directivity as a gesture to American tastes.

All is clean except for a little choral "blur and blast" in the louder passages. It was a pleasure to hear a true *pianissimo* on a record, the wonderful *DGG* surfaces permitting this with nary a "pop" or hiss to distract and annoy. If you are at all addicted to big choral works, this should provide much pleasure.

ORFF
CARMINA BURANA
Janice Harsanyi, soprano; Rudolph Petrak, tenor; Harve Presnell, baritone; Rutgers University Choir, with Philadelphia Orchestra conducted by Eugene Ormandy. Columbia Mono ML5498. Price $4.98.

This is the third (or is it the fourth?) recording of this controversial work and one of the best. By now most people are familiar with Orff's odd musical language, his use of the human voice as an instrument of rhythm as well as purely tonal considerations, and his odd pairings and use of percussion. Whatever you call it, you can't ignore it. It has a fascination in its weirdly complex sounds.

Ormandy does a first-class job and has by far the better orchestra, but the Stokowski version has more rhythmic precision and generates more excitement in his handling of tonal masses and the instrumental combinations at tempi which are more brisk than Ormandy's.

This sound is good mono, except that I would have liked more choral articulation and there were some unusual "thumps" and other variety of low-frequency noises the first six or seven minutes at the beginning of the record. I suspect it must be a pressing defect, for *Columbia* would never pass this if it were inherent and on the tape.

DVORAK
SYMPHONY #4
CARNAVAL OVERTURE
London Symphony conducted by Antal Dorati. Mercury Stereo SR90236. Price $5.95.

More Dvorak, this time his superb "Fourth Symphony" is another of this month's outstanding recordings. This, too, is a pinnacle in the recording art. It has all the attributes of directivity and instrumental positioning and good depth and a lush acoustic perspective making for tremendous presence.

The dynamic range is very broad and the recording is as distortionless as I have heard in a long time. Every choir . . . the strings, winds, brass and percussion . . . is reproduced with startling clarity and articulation.

Dorati's reading may not have the *gemutlichkeit* of a Bruno Walter, but I like his earthy and vigorous approach which imbues the work with much life. The London Symphony has progressed an incredible distance in the past three years and this is evident in the playing on this and other recent discs. They deserve an accolade as one of the best, if not the foremost, orchestra in England today.

As a musical and thrilling hi-fi experience, this disc is most heartily recommended.

BEETHOVEN
SYMPHONY #7
New York Philharmonic conducted by Leonard Bernstein. Columbia Mono ML5438. Price $4.98.

The umpteenth Beethoven "Seventh," but a version of quite some merit. This is conducted by Bernstein with characteristic drive and spirit. His tempi never flag and, all in all, his somewhat brash approach sneaks up on you and you feel simply hurled along by his impetus.

Probably this is not to everyone's taste—I still prefer the Klemperer reading myself—but on the other hand a fresh insight into a work that too many others drag to the point of maddening distraction.

The sound is excellent mono, recorded at just the right distance for good detail with spacious acoustics.

PROKOFIEV
ALEXANDER NEVSKY
Rosalind Elias, mezzo-soprano with chorus directed by Margaret Hillis. Chicago Symphony Orchestra conducted by Fritz Reiner. Victor Stereo LSC-2395. Price $5.95.

This is that rare animal, not just a "good" recording but a great achievement. This is one of the truly outstanding discs of the stereo era and it will take some doing to surpass it. From every aspect, this is masterful, the score is one of Prokofiev's most dramatic and accessible, Reiner's performance is stunning—with every tempo just right to heighten the dramatic action—the playing of the Chicago Symphony and the inspired choral work are miracles of tonal lushness and precision.

The sound must be listed as one of *Victor's* greatest achievements. Except for a rare spot here and there where the complexity of the scoring and the great dynamics tend to obscure the first strings or some wind passages, this is a stereo delight. The engineers took full advantage of the incomparable acoustics of Chicago's Orchestra Hall and the sonorities produced are positively awesome.

Here is the magic blend of detail and good stereo separation combined with great rounded spaciousness that affords a feeling of presence rarely encountered on a record. The brasses, even down to the dark hues of the tuba, are almost palpable and you can very nearly "taste" them. The strings are smooth, soaring delights and the contrabassi can be heard with their characteristic timbre even when they are playing at the extreme bottom of the dynamic scale.

The percussion is unbelievable. If you have the equipment to do the proper job, this recording should finally dispel any notions that extremely low bass cannot be engraved on a stereo disc. There is one of the biggest bass drum

sounds ever recorded—from great huge triple *forte* whumps, which have shattering impact, to the equally impressive softly stroked passages which, in spite of their low dynamic values, are completely clean and articulate.

BERLIOZ
THE DAMNATION OF FAUST
Consuelo Rubio, mezzo-soprano; Richard Verreau, tenor; Michel Roux, baritone; Pierre Mollet, bass; Choir Elisabeth Brasseur, with Orchestra Lamoureux, Paris, conducted by Igor Markevitch. DGG Stereo 138099/100. Price $11.90. Two discs.

Another big production from *Deutsche Grammophon* and very impressively done it is. The singers are very French as they should be for this work, even though some might have wished for more illustrious names. The Choir Brasseur are old hands with this material and Markevitch is really in his element here, turning in a performance that is obviously a labor of love.

Soundwise, this was recorded in the Salle Pleyel, a hall for which I have no great love, but the *DGG* engineers have succeeded quite well in overcoming most of its faults.

If this is one of your favorites, I don't think you will be disappointed in this recording and since they are not likely to issue something like this every other month, it is probably a safe buy.

All for now and I hope to have many, many reviews for you next month. [30]

N.Y. Hi-Fi Show

(*Continued from page* 39)

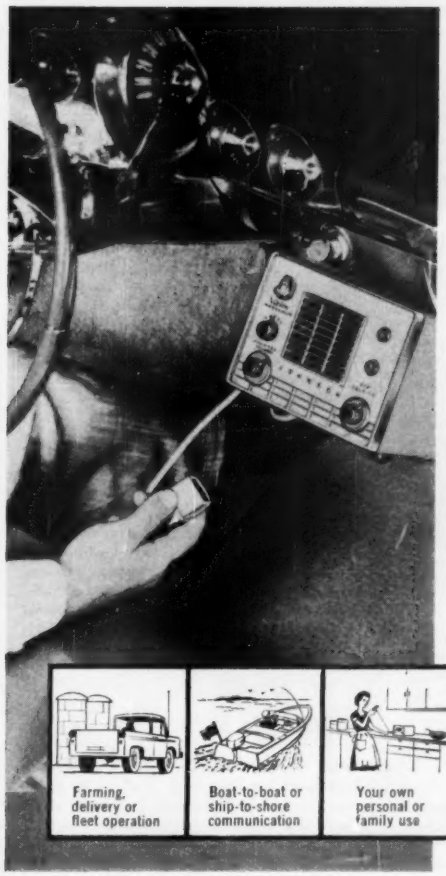
range electrostatics and the design should prove very easy to install in a variety of situations. The stereo effects I heard were minimal and there was very little "presence" . . . the sound seemed to be "retracted" behind the speakers. When playing the new *Victor* "Alexander Nevsky" disc (reviewed in this issue) which has some huge bass drum sounds, very little could be noted. As I said earlier, a Show is a poor place for evaluation and although any new product is certain to have "bugs," I don't believe the *KLH* people would exhibit a speaker if what I heard were inherent characteristics. Thus, I think it only fair to hear this speaker again under optimum conditions.

For those seeking stereo monitoring headphones, the *Koss* exhibit had several models to pick from and try out while the devotee of electrostatic speakers found the *Neshaminy* display of interest.

Jim Lansing was again demonstrating his special "Ranger" stereo speaker and the sound is as impressive as its bulk. Irving Friend, the impressario of *Lectronics,* Philadelphia, was showing one of the most talked about arms at the Show, the expensive and beautiful *SME* unit. This has about every adjustment imaginable and its very novel hydraulic lowering and lifting device will be a boon to those whose hands are not as steady as they would like. He was also showing the only other full-range electrostatic speakers at the Show, the "Quad" units. These have been maligned in the past as giving very poor bass response, but as driven by "Quad" amplifiers and the new *SME* cartridge in the *SME* arm, it had very solid, respectable bass down to below 40 cps.

That wily Scot, Frank *McIntosh* and his diminutive dynamo of a partner, Gordon Gow, made the *McIntosh* exhibit one of the Show standouts. As you know, I have been harping on the inadequacy of the commercial "packaged" units . . . the mahogany monstrosities that produce a parody of stereo sound. Well, friends, these units are bad enough when they are in prime operating condition, but just let something go out of whack and then you've had it. Oh yes, these units are warranted, usually for a year, but if you read the small print, you will find that you are going to be stuck for a bill for parts or labor, or both. And, if by chance a new advance comes along, why you just toss out the whole shebang if you want to keep up with the Joneses. This is just another reason why for true hi-fi stereo sound you can't beat components.

To prove this point, *McIntosh* set up what was called a "maintenance clinic" and, believe it or not, Show visitors were invited to bring in any model of *McIntosh* amplifier, preamp, or tuner and



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have it checked and tested. If anything was found to be substandard, the unit was put into perfect condition and the owner was not charged for either parts or labor. I wonder how many package "hi-fi" manufacturers would back the reliability of their products in such a fashion? Some of the statistics on this "clinic" are interesting. With two men handling the work, over 280 pieces of equipment were processed. A considerable number of people brought their units in "just to be sure that everything was OK." If repair was necessary, a unit left at the clinic in the morning was ready for delivery that same night. Less than a half a dozen pieces of equipment proved beyond the facilities at the clinic and had to be returned to the factory.

New from *McIntosh* was an integrated two-channel, single-chassis stereo amplifier, the Model 240, which provides operation either as a stereo unit with 40 watts to each channel or as an 80-watt monophonic unit. *Marantz* was also showing a new stereo amplifier of 40 watts each channel. The unit looked massive and professional in a special metal "cage" with the familiar *Marantz* "performance" meter set in the middle of the dress panel.

Pickering products were being demonstrated by genial George Petiten, one of the real old timers in the hi-fi business, who was justifiably proud of his new "Professional" series stereo cartridge, claimed to afford unusually wide separation over the entire frequency spectrum. *Radio Frequency Laboratories* showed a line of integrated stereo speaker systems which, with their luxurious finishes and beautiful styling, will be sure to appeal to the ladies. *H. H. Scott* was showing an extensive line of tuners and amplifiers but what fascinated me was another example of a manufacturer of components standing squarely behind his product. I refer to the offer made to people who have purchased the *London-Scott* integrated stereo arm and cartridge. The stylus armature supplied in the original unit was extremely thin and offered tremendous compliance which provided very fine tracking but was thought by many users to be too delicate and fragile. I own one and I have not had any trouble and I would not want to replace the armature, but for those who are perhaps a bit heavy-handed and have run into trouble, *Scott* asks that they return the unit to the factory and a new armature of more robust construction will be installed at no charge.

Sherwood was displaying its line of attractively styled amplifiers and tuners as well as a neat multiplex adapter unit. *Thorens* was showing its turntable line and had a unique exhibit designed to demonstrate the precision of its mechanical structures. *Transitronics* gave us another look at a possible future with a line of neatly designed transistorized amplifiers and preamps. They will no doubt be showing up with amplifiers of much higher ratings in the near future.

In *University*'s room, Vic Brociner was conducting a very interesting A-B test with the company's new "Spheri-con" tweeter and an electrostatic tweeter. Paul *Weathers* finally introduced the long-expected stereo version of his FM-capacitance pickup. The sound was superbly clean and features extreme separation. Most people were quite amazed at the tracking pressure with this unit which is all of a half of one gram! The oscillator is now factory set and sealed so no further tuning is necessary. Best news to many who own *Weathers* mono units is that they can be converted into the stereo version.

Well, that is about it friends, if I have left out some people or missed some significant new products, I can only say I'm sorry. Covering a Show of this magnitude isn't easy on the feet and I am not exactly sylph-like!

For details in the field of tape and information on some of the tape exhibits at the Show, refer to my column "Sound on Tape" on page 88. [30]

NOVEMBER 28-29

NAB Fall Conference. Sponsored by National Association of Broadcasters. Biltmore Hotel, New York, N.Y. Program details from NAB Headquarters, 1771 "N" St., N.W., Washington 6, D.C.

DECEMBER 1-2

Eleventh National Conference. Sponsored by Professional Group on Vehicular Communications, Institute of Radio Engineers. Sheraton Hotel, Philadelphia. Program information available from Douglas N. Lapp, Tele-Dynamics Inc., 5000 Parkside Ave., Philadelphia 31, Pa.

DECEMBER 12-14

URSI-IRE Fall Meeting. Sponsored by the Boulder Laboratories of the NBS, USA National Committee for the International Scientific Radio Union, and Professional Groups of the IRE. Radio Building, Boulder Laboratories, National Bureau of Standards. Full details from National Academy of Science-National Research Council, 2101 Constitution Ave., N.W., Washington 25, D.C.

DECEMBER 13-15

1960 Eastern Joint Computer Conference. Sponsored by IRE, ACM, and AIEE. Hotel New Yorker and Manhattan Center, New York City. Details from the Conference, P.O. Box 2580, Grand Central Station, New York 17, N.Y.

ELECTRONIC CROSSWORDS

By BRUCE BALK

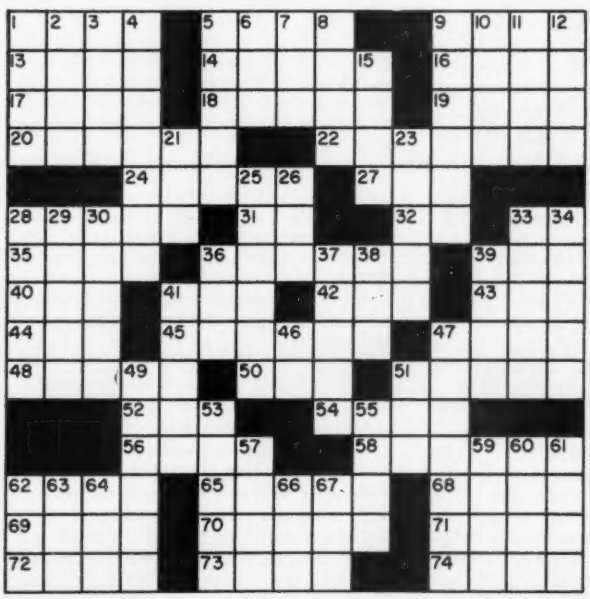
(*Answer on page* 131)

ACROSS

1. Propagated periodic disturbance.
5. Metric unit of mass or weight.
9. Bird.
13. Type of bridge.
14. Unit of visible flux.
16. Sound of laughter.
17. Sell.
18. Synonym for plate.
19. Send forth.
20. Young cow.
22. Discoloration on a TV cathode-ray tube.
24. Another designation for rare or noble gas.
27. Negative.
28. Cogwheels.
31. Range of frequency.
32. Symbol for internal shield.
33. Power factor (abbr.).
35. Angel (Fr.).
36. Stage whispers.
39. Wing (Lat.).
40. Suffix in verbs.
41. Animal doctor for short.
42. Employ.
43. Vehicle.
44. Member of a religious order.
45. Slumbering.
47. Transparent mineral.
48. Stand erect.
50. Teleost fish.
51. Granted.
52. Thin stick.
54. Male deer.
56. Electrode.
58. Optical counterparts of objects.
62. Character of reproduced sound.
65. Depleted (two words).
68. Barren.
69. Metal.
70. Measurement of the reciprocal of capacitance.
71. Ancient Egyptian God.
72. Confined.
73. Work on a manuscript.
74. Relax.

DOWN

1. NBS radio station.
2. Engineers' organization.
3. _____, vedi, vici.
4. Type of antenna array.
5. Piercing stare.
6. Race.
7. "I love" (Latin).
8. Prefix for middle.
9. Parts of the anatomy.
10. Incline.
11. U.S. state.
12. Unit of electrical power.
15. Rare gas.
21. Printers' measure (pl.).
23. Interference.
25. Sound of silk.
26. Combining form denoting the presence of sulphur.
28. Ratios of output to input voltage.
29. Follow.
30. Spy.
33. Location.
34. Unit of capacitance.
36. Engineers' organization.
37. Fights with swords.
38. Sixth sense; object of current research (abbr.).
39. Carbolic, for example.
41. Diffused matter.
46. College degree.
47. Absolute unit of pressure.
49. Important.
51. Part used to convert rotary to linear motion.
53. Component having two electrodes.
55. Petty quarrel.
57. Union of two; a pair.
59. A square-wave voltage.
60. God of love.
61. Relayed.
62. Contact at the end of a plug.
63. Unrefined metal.
64. Negative prefix.
66. Prefix meaning three.
67. Grain.



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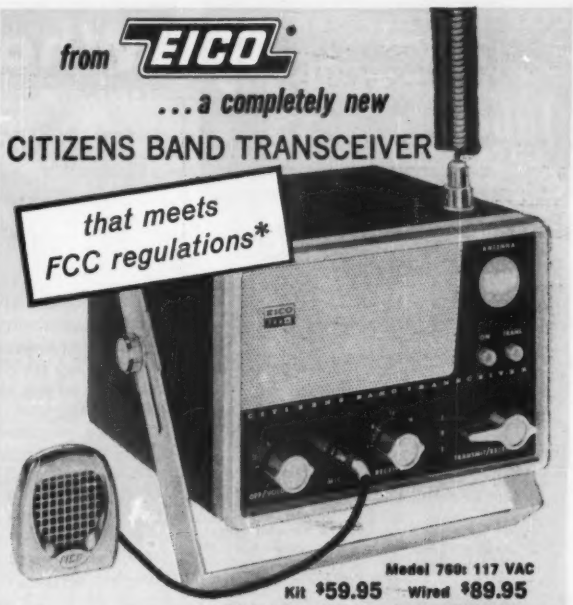

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*EICO premounts, prewires, pretunes, and seals the ENTIRE transmitter oscillator circuit to conform with FCC regulations (Section 19.71 subdivision d). EICO thus gives you the transceiver in kit form that you can build and put on the air without the supervision of a Commercial Radio-Telephone Licensee!

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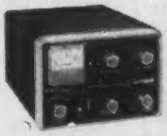

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Kit $49.95 Wired $79.95
Delivers 50W undistorted audio. Modulates transmitters having RF inputs up to 100W. Unique over-modulation indicator. Cover E-5 $4.50.

Grid Dip Meter #710
Kit $29.95 Wired $49.95
Includes complete set of coils for full band coverage. Continuous coverage 400 kc to 250 mc. 500 ua meter.

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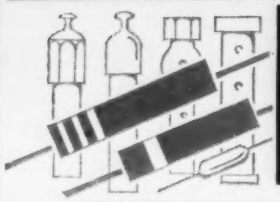
What's New in Radio



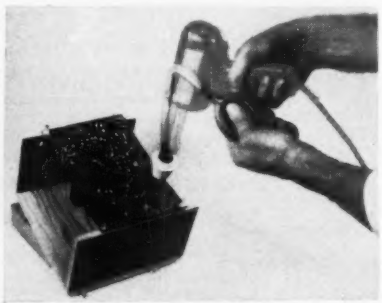
TRANSISTOR INVERTER

Arkay International, Inc., 88-06 Van Wyck Expressway, Jamaica 18, N. Y. has released its Model 2-120W transistor inverter, which converts the 12-volts from a car or boat battery to the 110 volts required for standard home appliances. Thus it facilitates using such units as a TV set, tape recorder, and the like in a vehicle or at picnics and so on where the vehicle is accessible.

Using no moving parts, the 2-120W inverter weighs 5½ pounds and is approximately 10" x 4". It is available in factory assembled or kit form. For additional details, write to the manufacturer.

SOLDERING AID

Cyclops Mfg. Corp., 20839 Fenkell, Detroit 23, Mich. has announced a new attachment for soldering guns that is designed to reduce parts replacement time on printed circuit boards. The unit consists of a special desoldering tip, a



porcelain bowl, plastic tube, and rubber suction bulb. The bulb is pressed to draw the melted solder up into the cup.

The new attachment is said to eliminate overheating terminals on etched boards as well as the need to clean or ream out the eyelet hole. For additional information, write to the manufacturer.

ISOLATION TRANSFORMERS

United Transformer Corp., 150 Varick St., N.Y. 13, N.Y. has introduced a series of ultrashielded isolation transformers (hermetically sealed to MIL-T-27A specifications, type TF-4RX01YY) which simulate battery operation. They are designed for extremely critical circuits requiring the ultimate in isolation for power-line equipment. The effective capacity coupling between primary and secondary windings is less than 0.1 $\mu\mu$f. Even this minute capacitance can be reduced, according to the manufacturer, by optimum circuit design suited to the individual application.

HEATHKIT CB TRANSCEIVER

Heath Company, Benton Harbor, Mich. has announced its Model GW-30, a hand-held Citizens Band transceiver available in factory-wired or kit form.

The GW-30 is designed, according to the manufacturer, for sharp, clear two-way portable communication in applications requiring no license. Additionally, the unit meets FCC requirements for licensed use in communication with regular class D CB stations. With appropriate crystal, the unit also can be used by radio amateurs on the 10-meter band. The battery-operated 4-transistor circuit features a fixed-tuned superregenerative receiver with its inherent noise-limiting properties. The crystal-controlled transmitter uses maximum FCC-allowable input with optimum efficiency for signal clarity and strength.

The unit is housed in a black simulated-leather case with polished aluminum front panel and a leather shoulder carrying strap. It has a volume control, push-to-talk button, and telescoping whip antenna.

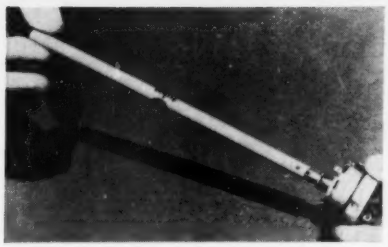
TV CLEANSER

Abbott-Lane Industries, Bellmore, N.Y. has introduced "Visionkleen," described as a new pelletized all-purpose cleaner, said to be an easy-to-use, economical, and effective agent for keeping television screens and tubes free of dust and grime.

To use it, a person drops one pellet into a plastic spray dispenser, adds eight ounces of tap water, sprays the mixture on, and wipes the dirt off.

CONTROL EXTENSIONS

General Electric Co., Schenectady 5, N.Y. is offering two non-slip rear-control extension rods that will permit TV service technicians to adjust height and vertical linearity on receivers.



The extension rods are tapered to fit over control shafts, and may be used on either knurled or slotted shafts. They eliminate the "slip problem" that may be present when a screwdriver is used for these adjustments.

TUBE DATA PADS

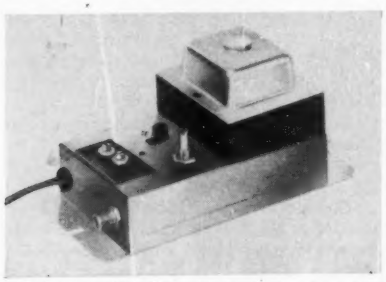
Tronic Pad, 5959 St. Hoover St., Los Angeles 44, Calif. is offering a series of "Tronic Pads" which resemble scratch pads, but contain characteristic curves of transistors and tubes. Multiple copies are available for detailed circuit analysis.

Load lines and other notations can be drawn on the curves. Circuit designs can be sketched on individual sheets for comparison. Carbons may be inserted to provide duplicate copies. A pad contains 25 data sheets of one tube type; a package contains ten pads. Pad size is 4¼" by 7".

MAST-MOUNTED PREAMP

Jerrold Electronics Corp., 15th and Lehigh Ave., Philadelphia 32, Pa. has introduced the Model DSA-202, a new low-cost addition to its line of "desnower" preamplifiers for improving TV and FM reception in fringe areas.

The new unit provides 20 db gain for all v.h.f. television channels, while a



minimum of 8 db gain is claimed at 108 mc., the extreme edge of the FM band. Designed to be mounted along the mast of an antenna, the preamp is furnished with a power supply, Model 407P, which may be installed remotely.

CONTINUITY CHECKER

EDP Corporation, 3501 S. Orange Blossom Trail, Orlando, Fla. is now offering a new transistorized continuity checker, the "Con-Chek."

The unit produces a clear and distinctive audible tone for continuity, a higher pitched tone for low-resistance circuits, and a crackled "hashy" tone for intermittents. "Opens" produce no tone. There is no tone produced on circuits having more than 100 ohms of d.c. resistance, nor will it respond to high inductance circuits.

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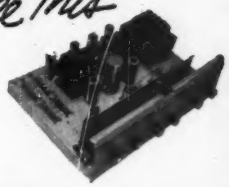

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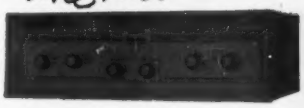

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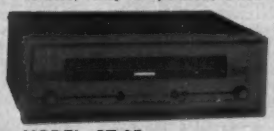
AM-FM SIMULCAST stereo tuner in kit form. Sensitivity—2 μv for 30 db quieting. MPX facilities.
MODEL ST-45—Kit $84.95
MODEL ST-45PA — Semi-Kit, with AM and FM tuner sections wired, prealigned and calibrated. .$99.95
MODEL ST-45W—Wired, aligned, calibrated, ready to operate .$134.95



MODEL ST-35

FM TUNER KIT. Sensitivity, 2 μv for 30 db quieting. Easily adapted for MPX and stereo.
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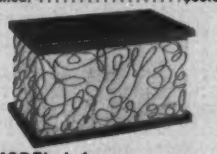
MODEL ST-35PA — Semi-Kit, tuner section wired, prealigned. .$69.95
MODEL ST-35W—Wired, aligned, calibrated, ready to operate . .$89.95

MODEL L-2

2-WAY, SPEAKER-SYSTEM SEMI-KIT. 10" Jensen woofer and horn-type tweeter. Response, 45 cps to 15 Kc. 23½" W x 13" D x 12" H.
MODEL L-2U—unfinished birch $59.95
MODEL L-2F—walnut, furniture-finished. $69.95



MODEL L-1

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ALL MARINE FREQ.-FT-243, DC-34 Hold Tol. .005....$2.00
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CITIZENS BAND—11 METERS—.005% TOL.
26.965 to 27.225 MC, 3rd Over. Herm. Seal. or
FT-243.....$2.50
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FT-243 ..... $2.50
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The "Con-Chek" is pocket sized and weighs only 11 ounces. It comes complete with a self-contained battery and test leads.

POCKET-SIZE TRANSCEIVER

Ross Laboratories, Inc., Seattle, Wash. has introduced a fully transistorized two-way radio small enough to be carried in the pocket. Named "Pocket-Talkie," it is claimed to provide reliable short-range communication.

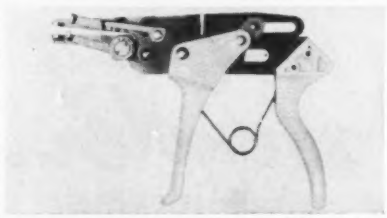
The set may be operated under a special provision of the 27-megacycle Citizens Band which requires no license or permit. Basically, the CB high frequency is a line-of-sight communication system, and range will vary with application and terrain. A reasonable range in fairly open country would be 2 miles, and under very favorable conditions, 3 miles. In a crowded city among tall steel-re-inforced buildings, the range would be one or two blocks.

The unit operates on a single dry cell battery at an average cost of less than two cents an hour. It weighs a half-pound.

WIRE STRIPPER

Utica Drop Forge and Tool Division, 2415 Whitesboro, Utica 4, N. Y. has announced what it terms a revolutionary new wire stripping tool. Called the "Stripwright," it cleans and strips most types of insulation including Teflon on both solid and stranded wires.

The "Stripwright" has a squeeze grip and slide action. It is equipped with a



cam-action calibrated dial which can be adjusted to strip from No. 12 to No. 26 wire with a full range from 0 to .080 inch. Variations in wire size can be compensated by a flick of the user's thumb.

The tool, which weighs 7 ounces, has a pistol-type design that facilitates its use in limited access areas.

CHEMICAL CLEANSER

Electronic Chemical Corp., Jersey City, N. J. has announced a new product and formula, EC-44, which is intended to lubricate, condition, and clean all electrical contacts. The 6-ounce spray can containing the solution is being offered with a free 5-inch plastic extender push-button assembly.

The new liquid has an electrical resistance which lowers as temperature increases. Since point contact is eliminated as current builds up or drops off gradually, EC-44 is credited with reducing arcing as well as being an aid in reducing radio and television interference.

DEMONSTRATION SYSTEM

Seg Electronics Co., Inc., 1778 Flatbush Ave., Brooklyn 10, N. Y. has announced its radio demonstration system for use in dealers' showrooms.

The new system, according to the company, does for radios what a master antenna does for television receivers. It uses a concealed loop antenna and booster to supply signals to receivers for best, interference-free reception. The system, which is not connected to the sets, may be concealed behind display shelves as long as it remains in proximity with the sets being demonstrated.

GRID CIRCUIT TESTER

Seco Electronics, Inc., 5015 Penn Ave. So., Minneapolis, Minn. has introduced its Model GCT-9, said to be the first and only grid circuit tester that offers complete coverage of all TV tube types, including voltage amplifiers, power output and heater-type diodes, hundreds of foreign and industrial types, as well as types with grid, plate, or cathode caps.

It permits tests for grid emission, leakage, shorts, and gas in one operation and indicates results instantly and visually on a 6AF6 "eye" indicator. All tubes are checked within tube manufacturers' recommended limits by the d.c. testing process.

For additional details, contact the manufacturer.

CITIZENS BAND TRANSCEIVER

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N.Y. is offering a new "deluxe" Citizens Band transceiver. Designated as the HE-20, and operating within FCC prescribed limits, the new set can span distances up to 20 miles, depending on terrain and antenna height.

A built-in 12-volt power supply readies the HE-20 for mobile use. Other features include: "S" meter with switch to measure signal strength and to check on wattage input to final stage; fourteen tube performance; four crystal-

controlled receiver positions, plus tunable receiver over all 23 channels; four crystal-controlled transmit positions. Also included is an adjustable squelch control, a highly effective automatic series-gate limiter, push-to-talk ceramic microphone and relay, and illuminated dial. A 4-inch speaker is driven by a 2-watt audio output section.

With each HE-20, the manufacturer supplies a complete set of matched crystals for channel 9.

POCKET SIZE METER

Audiotex Mfg. Co., Division of *Textron Electronics, Inc.*, 400 S. Wyman St., Rockford, Ill. has announced a new

"pocket meter," Catalogue No. 30-240. The 6" by 4" instrument serves as d.c. voltmeter, a.c. r.m.s. voltmeter, ohmmeter, decibel meter, and d.c. micromilliammeter. Additionally, it reads inductance, capacitance, and relative signal output.

The instrument is supplied with a pair of test prods and full instructions.

AXIAL-LEAD RESISTOR

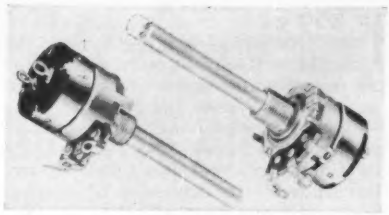
International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. has added a 3-watt axial-lead wirewound power resistor to its "PW" line. The new product features fireproof inorganic construction. It is said to answer a long-time need for a commercial version of a power resistor where size and cost savings are of prime importance, but where military specifications are not a necessity.

Resistance elements of the unit are uniformly and tightly wound on glass fiber cores. Tinned copper leads are secured to the element, and the element-lead assembly is sealed in a rectangular ceramic base. The PW-3, as it is designated, is manufactured in a resistance range from 0.24 to 6200 ohms, and in standard tolerances of ±5% and ±10%.

PUSH-PULL SWITCH

Stackpole Carbon Co., Electronics Components Div., St. Marys, Pa. has announced a new pull-on, push-off switch for use in conjunction with variable resistors. Known as Type G-16, the switch is said to allow for greater convenience in operating radio and TV receivers, hi-fi equipment, instruments, and other devices.

It can be furnished on many of the company's single and dual-section variable resistors. The switch operates from



the same shaft used to control the resistor.

TWO-WAY CB RADIO

Radio Corporation of America has announced a new four-channel Citizens Band radio for transmitting and receiving ashore or afloat.

Known as the "Radio-Phone Mark VII," the set features four crystal-controlled channels as well as a tunable receiver covering all 23 channels in the CB range.

Two models are available, one for use on 117-volt a.c. or 6-volt d.c. power sources, and the other for operation with 117-volt a.c. or 12-volt d.c. sources.

MINIATURE TUBE SOCKETS

Garlock Electronic Products, Camden 1, N.J. has introduced a new series of "Chemelec" 7- and 9-pin miniature tube sockets.

Available with saddles or shields, the new sockets are designed for high-frequency service in electronic equipment where low loss factor and dielectric constant are required. [30]

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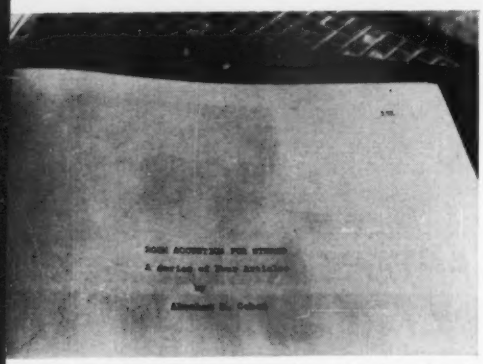
IF YOU collect back issues of this or any other magazine, perhaps for the magazine itself but more usually for one or two interesting articles contained in a particular issue, you soon find yourself being crowded out of whatever storage space you may have. Most of the time, however, you save reams of useless material for the sake of keeping what copy you do want.

A writer probably reads, and collects, more magazines than anyone and it rapidly becomes necessary to find some way of saving only the wanted material and dispensing with the rest. For that reason, the author has been binding back articles for some time and a number of useful tricks he has developed in the process are being passed along.

The important part is deciding what to keep and what to throw away. Any article of a practical nature, either directly or indirectly related to your own particular interests, is worth keeping even if it seems to have no use at the time. This includes reports on new techniques, as well as construction features. Even if you can't use the information now, sooner or later a use for it will turn up. If it doesn't you can still throw the unwanted material away.

All articles in a series, for instance, become more usable and easier to consult when they are removed from issue and filed together in a sturdy cardboard binder.

First step is to disassemble book by removing cover and opening staples holding the pages.



An accurate and complete index is a "must" or the entire system becomes a shambles.

Bind Your Back Issues

By JOHN BERRIDGE

Articles dealing with your special interests or hobbies can be clipped and filed in permanent form, as outlined.

Most quality magazines these days are "stitched" together with metal staples with the front and back covers, in one piece, stuck over the top. Pull the magazine apart by tearing off the cover sheet down the spine of the magazine. Use a pair of pin-nosed pliers to remove the staples, then pull the various sections of the magazine apart. This publication, for instance, is folded into several sections, which are then glued together down the backs. The complete magazine can be reduced to its individual sections with a little care. Discard the sections which don't contain anything you wish to keep. Trim the sections to a particular size by using a knife and straightedge down the back edges. Scissors will produce a more ragged result. If you are filing articles from several magazines of the same relative size, trim all the paper to the size of the smallest. This generally means removing no more than a quarter-inch at the most.

Finding a good binder is also important. The usual type of three-ring binder does a poor job, even when the punched holes in the paper are re-in-forced. The pages get torn too easily as they are turned over. One of the best binders to use is the "Accopress" binder which pinions the backs of the paper with a soft metal strip. It also has a much greater capacity than a three-ring binder, and it is readily available at stationary stores.

This same company has recently come out with another type of binder, the "Accogrip," which holds the paper under a strong clamp, thereby eliminating the need to punch holes in the paper. The same binder also makes it much easier to remove individual articles for reference purposes. If you prefer to use the "Accopress" or similar binder, reverse the clamping strips so that any additions are made to the *back* of the file. If this is done, a simple numbering system can be used for indexing purposes.

Indexing the file is a *must* if you refer to the file frequently. You can file under subject matter but the simplest method in the long run is just to number the articles consecutively as you add them to the file, then include an index at the back. Any additions are given the next highest number and the appropriate data added to the index. This system is much quicker to use and it is possible to find any particular article in a matter of seconds.

The only complication is when portions of two or more articles appear on the same page. In this case file all the conflicting articles under one heading with the pages in numerical order as they were in the magazine, and index accordingly. You can add these heading and index sheets by using blank typewriter paper of the same size as the articles, numbering them in the top right-hand corner with the title roughly one-third of the way down the page. If you used colored sheets, of the type available for "second sheets," the title and index pages will stand out very clearly.

Add the finishing touch by labeling and numbering the front cover of the binder. One final word. The one time you *shouldn't* strip magazines to use this filing system is when you own every issue of the magazine ever published. A collection like this is too precious to tear apart and should be properly bound in some other fashion. Except for this case, the system outlined works fine in helping to preserve worthwhile material for years. [30]

1961 British Trends

By PATRICK HALLIDAY

BRITISH radio and TV trends for 1961 were revealed recently at the annual National Radio Show in London. Seen for the first time were combination AM-FM transistor portables—usually with 9 transistors and 4 crystal diodes—costing about $65.00 and TV sets incorporating "electronic eyes" to adjust contrast settings automatically with changes in ambient lighting, as when curtains are drawn or lamps switched on. This form of automatic contrast control, already popular in Continental Europe, depends on resistance changes of up to about 0.75 megohm in light-dependent cadmium-sulphide photocells. The cell, mounted on the TV cabinet in a position where it is unaffected by the tube screen light but exposed to changes in room lighting, may be connected between the video amplifier and the picture tube or, alternatively, forms part of the normal automatic picture control network.

Frame-grid tubes are now being widely used in TV sets to increase sensitivity and so permit indoor antennas to be used over wide areas. New 23-inch picture tubes have been introduced by several firms following the recent trend toward 21-inch screens, although the very popular 17-inch models still account for almost 90 per-cent of sales.

Fully transistorized TV sets have been shown by some makers, including a 14-inch direct-viewing *Pye* set with 26 transistors, 11 germanium diodes, 3 silicon diodes, and a high-voltage tube rectifier. With built-in rechargeable battery, the set weighs about 38 pounds. Prices have not been announced but are likely to be between $300 and $400.

For more than a decade tape recorders have been marketed in the United Kingdom mainly by specialist firms, but recently the principal suppliers of radio and TV sets have moved increasingly into this field; although the tape decks are often made by firms used to mechanical engineering in the phono equipment market. Simple tape recorders often operate at a single speed (3¾ ips) and cost around $65 to $90, as compared with high-fidelity models costing up to about $300 for domestic use. These generally have three-speed decks for 7½, 3¾, and 1⅞ ips speeds.

Four-track recorders for mono or stereo work are available in most price ranges. An ingenious mechanism with transistorized preamplifier is marketed at just over $30. It will convert any phono reproducer into a tape recorder. Fully transistorized tape recorders vary from simple models which dispense with the high-frequency bias oscillator to models for line/battery operation.

The trend in radio and TV prices is downward; current models being generally about 5 per-cent lower than a year ago. This reflects a determined attempt to overcome the decline in TV sales which set in early in 1960, following the boom year of 1959. [30]

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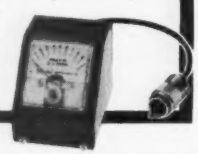

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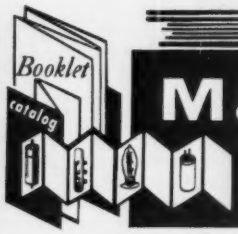

Manufacturers' Literature

KURMAN RELAYS

Kurman Electric Co., 191 Newel St., Brooklyn 22, N.Y. has issued a new catalogue of off-the-shelf relays. The brochure, No. 60-8, illustrates stock relays available from the company's sales agencies. Basic information has been simplified with a view to aiding engineers, buyers, and distributors in selecting standard relays for their applications.

Hundreds of relays are listed, with diagrams, prices, and complete electrical operating characteristics. Among the types shown are sensitive, power, antenna, microminiature, hermetically sealed, telephone, and multi-pole sensitive types.

STEPPING SWITCH CATALOGUE

C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill. has issued a 40-page, two-color catalogue on its complete line of stepping switches. Designated as Catalogue 202, it contains complete data on construction features, circuitry, and performance characteristics of the company's spring-driven, cam-operated, and direct-drive stepping switches.

COAXIAL PLUGS

Cannon Electric Co., Advertising Dept., 3208 Humboldt St., Los Angeles 31, Calif. has brought out a catalogue supplement describing its BNC series of r.f. coaxial plugs. The new 16-page booklet, Catalogue BNC-A, includes nomenclature, a mating functional diagram, BNC assembly instructions, *Kwik*-assembly BNC instructions, as well as illustrations and specifications for the jacks, plugs, receptacles, adapters, and other accessories.

BNC series plugs are designed for small coaxial cables. They are lightweight, weatherproof, and manufactured according to military specification MIL-C-3608.

The company also has announced a revised 20-page MS catalogue describing the MS-A (solid shell), MS-B (split shell), MS-C (pressurized) plugs approved to Specification MIL-C-5015. For a copy of either publication, write direct to the manufacturer.

TELEPHONE-TYPE RELAYS

Potter & Brumfield Division of *American Machine & Foundry Co.*, Princeton, Indiana is offering a four-page, full-color folder showing its complete line of telephone-type relays.

Featured in the folder is a chart listing electrical and mechanical characteristics of seven basic types of relays. Coil data and available enclosures also are included.

An unusual addition to the piece is a nomogram upon which the operating speed of the company's BS relay can be calculated.

COMMUNICATIONS COMMAND CENTER

Westrex Recording Equipment Department, 6601 Romaine St., Hollywood 38, Calif., has issued an illustrated, four-color brochure describing its "Communications Command Center."

Designed and fabricated by *Westrex*, the center is "human engineered" to provide maximum efficiency for command radio communications by police and fire departments as well as utilities and transportation companies.

UTC SUPPLEMENT

United Transformer Corp., 150 Varick St., New York 13, N.Y. has announced its new 1960-61 supplement catalogue. Printed in two colors, this 16-page booklet is an updating of last year's issue, and offers complete information on electric wave filters and high-*"Q"* coils. It is prepared for separate filing.

Detailed specifications on the company's line of stock items are given, as well as something of the extent of development in the art, providing the design engineer with a concept of the possibilities of present component design. A reactance-frequency chart also is included as well as further information on other *UTC* products: transformers, reactors, magnetic amplifiers, and pulse transformers. Mention also is made of some of the firm's engineering and production facilities.

DRAFTING STANDARD

The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N.Y. has published the first American standard to deal with the actual preparation of electrical diagrams. Approved by the American Standards Association, it has been designated as "American Drafting Standards Manual, Section 15, Electrical Diagrams, Y14.15-1960."

Included in the new publication are detailed recommendations on preferred practices for use in electrical diagrams, described as "ground rules," to eliminate divergent drafting techniques. Diagrams dealt with are single line or one line, schematic or elementary, connection or wiring, and interconnection.

The new Standard is available at $1.50 a copy from the ASME at the above address or from the ASA, Dept. PR 174, 10 East 40th Street, New York 16, N.Y.

NEWARK CATALOGUE

Newark Electronics Corp., 223 W. Madison St., Chicago 6, Ill. has released its 1961 catalogue. Designated as No. 71, the new publication lists over 60,000

industrial electronic parts, amateur, radio and TV components. Over 500 electronics producers are represented in this 452-page book.

Items are illustrated, described, and indexed. For a free copy, write to the company at the above address, or to *Newark-Inglewood*, 4747 W. Century Blvd., Inglewood, Calif.

MINIATURE TRANSFORMERS

Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, Long Island, N.Y. has issued its 1961 catalogue listing latest miniature transformers. Detailed specifications and diagrams are included.

The catalogue is designed for direct ordering of available off-the-shelf items from stocking distributors. Price lists and dealer lists are furnished. Among the miniature transformers described are typical special units, designed to customer specifications, as well as types for aircraft and missile applications, designed to meet MIL-T-27A and other military specifications.

SEMICONDUCTORS

Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix, Arizona has released an attractive, four-color brochure describing its complete line of industrial and military semiconductor products.

The 12-page booklet lists key specifications such as breakdown voltage, current capacity, operating temperatures, and power dissipation. Among the products offered in this line are germanium power transistors, audio and switching transistors, silicon and germanium mesa transistors, silicon rectifiers, and silicon zener diodes.

The brochure also provides information on this manufacturer's "Meg-A-Life" reliability program which makes "military equivalent" semiconductor devices available to commercial users of transistors.

ELECTROCRAFT CATALOGUE

Electrocraft Products Component Division, GC Electronics Co., 400 S. Wyman St., Rockford, Ill. has published a new 32-page fully illustrated catalogue describing recent developments in plugs, jacks, adapters, connectors, shielded jacks, cord-mounted jacks, and push-button switches.

Photographs as well as dimensional drawings accompany all product descriptions. Designated as Catalogue No. FR-61-E, the new publication is available free on request to the manufacturer.

SYNCHRONOUS MOTORS

Superior Electric Co., Dept. SS, 83 Laurel St., Bristol, Conn. is offering an 8-page brochure, "Slo-Syn Folder SE-L2604" which contains technical characteristics, specifications, ratings, and outline dimensions of new 50-, 150-, and 250-ounce-inch "Slo-Syn" synchronous motors.

Conventional, militarized, and explosion-proof types are offered with or without planetary gear speed reduction assemblies. All have a basic shaft speed of 72 rpm at 60 cps and can be used as constant-speed a.c. motors or as d.c. stepping or incremental positioning devices. A feature of these motors is instant starting, stopping, and reversing.

OPAD POWER SUPPLIES

Opad Electric Co., 43 Walker St., New York 13, N.Y. has issued a catalogue sheet describing and illustrating a new series of low cost, transistor-regulated d.c. power supplies.

The models described have an output voltage range of 4 to 32 volts d.c., with current ratings from 1.5 amperes to 15 amperes. Rated input is 105-125 volts a.c., 60 cycles, single-phase. Regulation is held to within ± ½% for line and load changes. Ripple does not exceed 5 mv. r.m.s.

TRANSISTOR CROSS REFERENCE

Workman TV Products, Inc., Box 5397, Sarasota, Florida has compiled a new cross-reference sheet listing almost 800 entertainment-type transistors. The guide lists both domestic private label and Japanese-made transistors.

The new guide also is available as a 17 x 22-inch wall chart, lithographed in two colors on heavyweight paper. [30]

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0Z4	3Q4	6AB4	6AX5GT	6CB6	6J4	6U5	7E7	12B4	12Q7	27
1A7GT	3S4	6AC7	6B8	6CD6G	6J5	6U8	7F7	12BA6	12R5	35A5
1B3GT	3V4	6AF4	6BA6	6CF6	6J6	6V6GT	7F8	12BA7	12SA7	35B5
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1L6	4BZ7	6AH6	6BD6	6CH8	6K7	6X5GT	7N7	12BF6	12SN7GT	35Z5
1N5GT	4CB6	6AK5	6BE6	6CL6	6M7	6X8	7Q7	12BH7	12SQ7	36
1R5	5AM8	6AL5	6BF5	6CM6	6Q7	6Y6G	7S7	12BQ6	12V6GT	38
1S5	5AN8	6AM8	6BG6G	6CM7	6S4	7A4/XXL	7X6	12BR7	12W6GT	39/44
1T4	5AT8	6AN8	6BH6	6CN7	6S7	7A5	7X7	12BY7	12X4	41
1U4	5AY8	6AQ5	6BJ6	6CQ8	6S8GT	7A6	7Y4	12CA5	14A7/12B7	42
1U5	5AZ4	6AQ6	6BK5	6CR6	6SA7	7A7	7Z4	12CN5	14B6	43
1V2	5BR8	6AQ7	6BK7	6CS6	6SD7GT	7A8	12A8	12D4	14Q7	50A5
1X2	5CG8	6AR5	6BL7GT	6CS7	6SF5	7B4	12AB5	12F5	19AU4GT	50B5
2AF4	5J6	6AS5	6BN6	6CU5	6SF7	7B5	12AQ5	12F8	19BG6G	50C5
2BN4	5R4	6AT6	6BQ6GT	6CU6	6SG7	7B6	12AT6	12K5	19J6	50L6
2CY5	5T8	6AU6	6BQ7	6D6	6SH7	7B7	12AT7	12K7	19T8	56
3A5	5U4	6AU4GT	6BR8	6DE6	6SJ7	7B8	12AU6		24A	80
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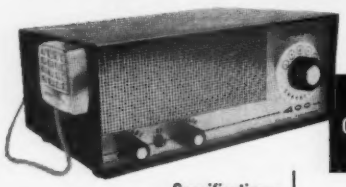

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Anechoic Rooms

(*Continued from page 32*)

For most large anechoic rooms, on the order of 15 feet by 15 feet, a window 18"x 24" works out nicely, providing it is correctly located. Under normal conditions a double-glazed ¼" safety glass has proven to be acoustically compatible with most wall panel construction encountered by the authors. However, each window design should be carefully matched to its own particular panel design. There are many sources, such as texts on acoustics, periodicals reporting on actual laboratory data, etc. to which one can turn in order to obtain transmission loss values of window glass in various thicknesses and with varied spacing between panes. The best source of information is, of course, the professional engineer with practical experience, combined with actual field tests.

Along with the proper selection of glass thickness and spacing is the design of tight rubber seals to hold the glass pane to the panel framing. Again, the window seals should be selected to prevent acoustic leaks around the window glass itself. Since the acoustic properties of the room are affected by the highly reflective properties of glass, an anechoic window plug which can be placed over the window during critical testing programs should be supplied. This plug consists of a structural framing to which wedges of the same design as the wall are attached. Once this window plug is installed, the wedges on this frame blend in with the wedges on the walls, ceiling, and floor, giving the room complete anechoic properties.

Ventilation System: A successful ventilation system depends on the careful selection of a blower as well as adequate silencing of the air going into the room and being discharged from the room. Fig. 7 shows one particular design for a ventilation system used in conjunction with an anechoic chamber. The normal anechoic room's ventilation system consists of a blower housed in a special enclosure, one silencer for the inlet air, and one silencer for the discharged air. The need for both inlet and discharge silencers is apparent when one considers the noise which the blower generates and the intake opening itself. Before the air is allowed to enter the room, the inlet silencer must be capable of filtering out any noise generated by the blower.

At the discharge end of the system, the opening through which the air leaves the room must be placed in one of the wall panels. In order to keep any noise in the area from entering the room through this opening, a special silencer must be placed over that hole to allow the air to move out of the room but prevent sound from entering it. Although their functions differ slightly, each of these two types of silencers is available commercially.

The blower unit selected must be capable of supplying the required amount of air through such a system. The blower, discharge silencer, inlet silencer, and the room itself, must all be part of

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the aerodynamic system. Proper sizing of the ventilation system can be handled by anyone familiar with airflow-pressure drop relationships. Insofar as the blower itself is concerned, the noise may be sufficient to disturb personnel working in its immediate vicinity outside the room. For this reason, a specially designed acoustic blower enclosure is provided. The enclosure, in addition to reducing blower noise, also helps to prevent the transmission of noise from the blower through the wall panels, which would raise the noise level inside the chamber.

These are just a few of the factors which must be considered in the design of an anechoic room. A good anechoic room, like any other job really well done, is a work of art that, in addition, has the truly functional purpose of providing the proper environment for making sound measurements. [30]

RUSSIAN TRANSLATIONS

THE National Science Foundation and the U.S. Department of Commerce have announced the arrival of the first group of Russian scientific and technical publications translated abroad as part of a cooperative Federal agency program which is being financed by the overseas sale of surplus U.S. agricultural commodities.

The translations were prepared by the Israel Program for Scientific Translations under contract with the National Science Foundation. Projects are now under way in Israel, Poland, and Yugoslavia to produce translations of 89,000 pages of scientific and technical material originally published in languages unfamiliar to most U.S. scientists.

The program will include a wide variety of technical and scientific subjects. The Office of Technical Services of the U.S. Department of Commerce receives, catalogues, distributes, and sells the translations at approximately one cent a page. In cooperation with the Special Libraries Translations Center at John Crerar Liberary, Chicago, OTS publishes twice monthly "Technical Translations" to announce new translations available and in process. This publication is sold on subscription. Write to the Superintendent of Documents, Government Printing Office, Washington 25, D.C. The annual domestic fee is $12.00 and $16.00 for foreign subscriptions. [30]

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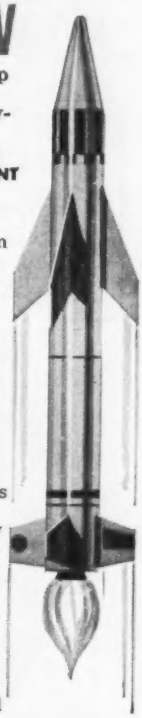

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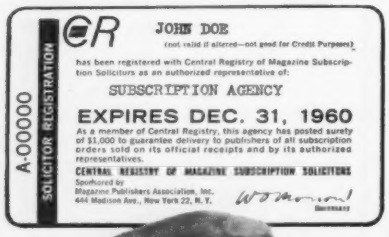
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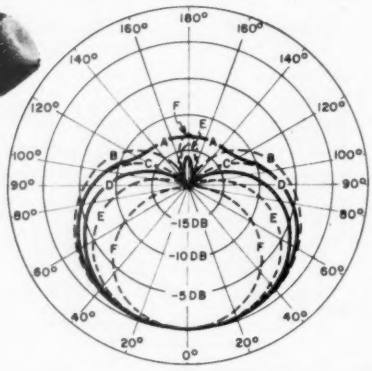
New Audio Test Report

ELECTRONICS WORLD — LAB TESTED

Shure 545 "Unidyne III" Microphone
Garrard SPG3 Stylus Pressure Gauge
Koss Model SP-3 Stereo Earphones
Dyna "Mark IV" Mono Power Amplifier

Shure 545 "Unidyne III" Microphone



A – AT 70 CPS
B – 70 TO 250 CPS
C – 250 TO 3500 CPS
D – 3500 TO 7000 CPS
E – 7000 TO 10,000 CPS
F – AT 10,000 CPS

Fig. 2. Cardioid polar pattern of the mike.

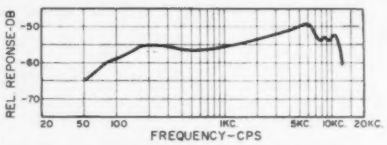


Fig. 1. Shure's response curve of the 545.

THIS is a unidirectional dynamic probe microphone designed for high-quality pickup of voice and music. Light in weight, the slim tubular mike is easily hand-held, and can be slipped into or out of a special clamp supplied with it for stand mounting.

The "Unidyne III" offers either high- or low-impedance (50 to 250 ohms) outputs, which are selectable by the appropriate strapping of the mike's output plug. A 25-foot length of three-conductor shielded cable is supplied, with a plug at one end (to fit the mike) and bare, tinned leads at the other end. Output is rated at −148 db (EIA rating), which is moderately high, and the manufacturer's published response curve is rather disconcertingly conservative (Fig. 1). However, the mike sounded quite a bit better than its published response curve would suggest.

It was very clean and crisp, with a slightly sibilant quality and a marked tendency to favor brass and percussion instruments. Its low end was tight and very well defined, although the deep bass range was noticeably deficient. Speech was natural and very intelligibly reproduced, as were male and female singing voices. Orchestral pickup was not so good, due mainly to the reduced deep-bass response noted previously, plus a tendency to make gut strings sound like steel ones. The "Unidyne III" has a somewhat stark, cold sound, but it is this very quality that makes it ideal for pickup of small bands and jazz groups (all temperatures).

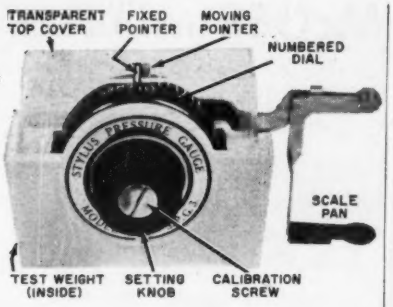
Its cardioid polar pattern is well-defined in both the horizontal and vertical planes and with remarkably little frequency discrimination (Fig. 2), so it can do an effective job of controlling knotty acoustic-feedback problems in p.a. set-ups. Incidentally, it would probably also lend itself very nicely to pairing, for stereo broadcasting and recording.

All in all, this is a fine general-purpose mike for use where directivity and intelligibility are of greater importance than very wide frequency range. The price of the mike is $51. [30]

Garrard SPG3 Stylus Pressure Gauge

ONE of the fanciest stylus pressure gauges that we have seen is the new *Garrard* SPG3. This unit measures stylus pressure up to just above 12 grams on a scale with widely spaced half-gram divisions. The gauge will work with all current pickup heads and arms whether in record changers or in manual players.

In operation the stylus is placed on a scale pan that is counterbalanced by a



coil spring. Tension on this spring is adjusted by a large setting knob that simply winds up the spring as it moves a large numbered dial under a fixed pointer in the transparent top cover. When the scale pan assembly is in perfect balance with the spring tension, a moving red pointer on the assembly lines up with the fixed pointer, thereby indicating stylus pressure.

A 5-gram test weight is supplied with the unit for occasional checking of the gauge accuracy. We first carefully adjusted the unit for the 5-gram reading using this test weight. Then we checked the gauge by weighing several precision weights used on an accurate chemical balance. Weights of 2, 5, and 10 grams were placed on the scale pan, and we were pleased to find that the gauge was "right on the button" at 5 and 10 grams and within a quarter gram at 2 grams. This kind of accuracy is certainly well within the limits needed for checking stylus pressures. We also could have checked the gauge by weighing ordinary coins on it. For example, a half-dollar should weigh in at 12½ grams, a quarter at 6¼ grams, and a dime at 2½ grams.

The SPG3 is available at local audio distributors for $2.95. [30]

Koss Model SP-3 Stereo Phones

FOR THOSE who prefer their stereo in private, a set of stereo earphones may be just what the doctor ordered. The set of *Koss* SP-3's that we have just tried out gave surprisingly good quality even at the low frequencies. Although not cheap as earphones go (they sell for $24.95), they should be a worthwhile investment for the stereophile who wants personalized listening or who doesn't want to disturb others in his household.

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Since the phones have a low impedance of only 4 ohms each, they cannot be used directly across any high-impedance circuits without shorting out the signal. They may, however, be connected where your speakers are connected, directly across the secondary of the stereo amplifier's output transformer windings. A switch could be installed to allow either speakers or phones to be used.

Because of the high sensitivity of the earphones, it may be necessary to just barely "crack" the gain control of your amplifier. Under these conditions, some amplifiers, especially the sensitive, high-power ones, may have more residual hum and noise than desired signal. By simply inserting a series resistor—we used a 12-ohm wirewound unit and made our connection to the 16-ohm tap—we were able to open up the volume pot a bit more to get a respectable signal-to-noise ratio. A low-value pot, or better still a T-pad, between the amplifier output and the phones will serve admirably as a level adjustment, thus permitting the amplifier's volume control to be advanced somewhat. We don't know how much power the phones will handle, but the loudness of their output would serve as a warning not to feed too much power into them and risk a possible burn-out.

The earphones themselves employ a pair of 3½-inch dynamic reproducers mounted in a special leather-finish plastic material housing. Sponge foam earpieces keep out extraneous sounds and permit the small diaphragms to produce respectable bass when clamped to the listener's ears. When we connected our audio oscillator to the phones, we were still hearing plenty of output down to 30 cps. At the high end, we could hear output up to 17,500 cps, where our ears, rather than the phones, probably cut off.

The stereo fan who sometimes wants his stereo *via* earphones will find a set of SP-3's a worthwhile addition to his stereo rig. [30]

Dyna "Mark IV" Mono Amplifier

IT SEEMS rather strange to be working on a monophonic power amplifier after spending so many of the past months on stereo units. Yet, it is an enjoyable venture since a mono power amplifier is one of the simplest of kits to build. This *Dyna* "Mark IV" 40-watt amplifier is among the easiest to build since the entire first stage, which includes the voltage amplifier and a phase inverter, is all pre-assembled on a printed circuit board. The design uses only four tubes in all, a GZ34 as a rectifier, a direct-coupled 7199, and a pair of EL34's as push-pull power output tubes in a distributed-load circuit.

Not only are the EL34's operated well below their maximum ratings resulting in longer life, but they employ a fixed bias arrangement providing more power at less distortion.

The results of our tests on one of the units we built show that the hum and noise was completely inaudible under normal listening conditions, being down 77.3 db from 2 watts under open-input

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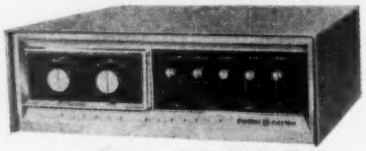

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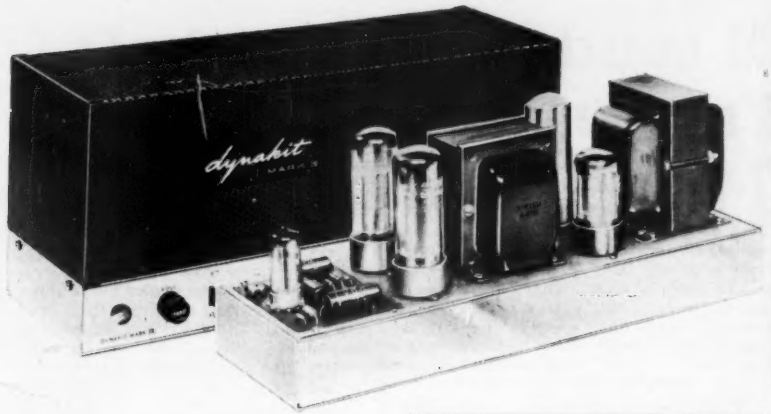


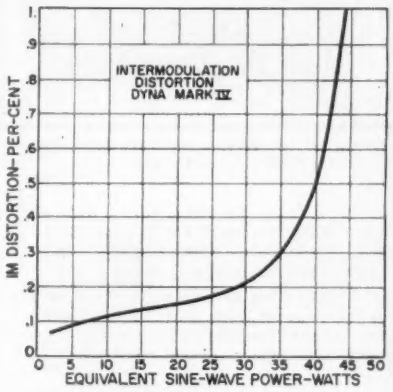
condition, and −88.8 db with the input shorted.

The sensitivity of the amplifier is 1.38 volts input for 40-watts output. This sensitivity is just a bit low compared to other amplifiers we have checked. However since most preamps will easily deliver this amount of output signal, there should be no problems in driving the amplifier to full output.

The frequency response was exceptionally good, being within ±.25 db from 10 cps to 35 kc. at the 2-watt level, and within ±.7 db from 25 cps to 30 kc. at its maximum 40-watt level.

The intermodulation distortion characteristics are shown in the accompanying graph. These figures were taken with 60 and 6000 cps at a 4 to 1 ratio.

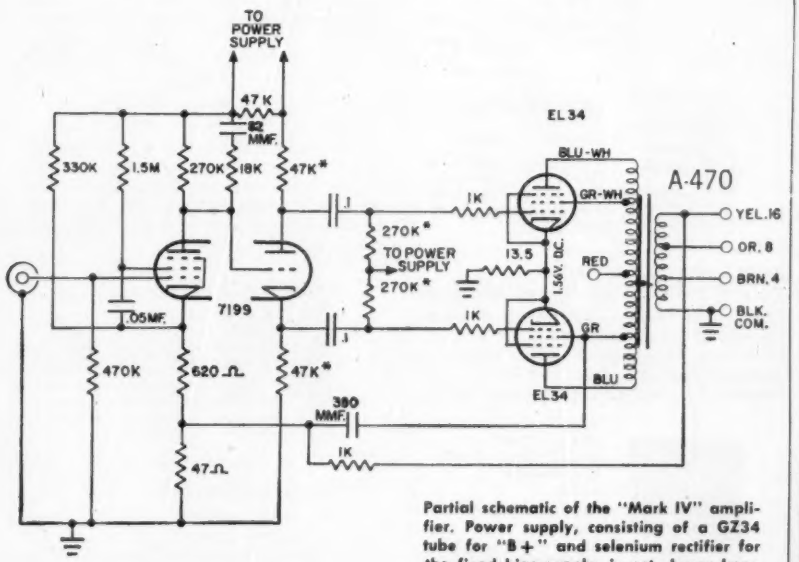
The harmonic distortion taken at the 40-watt level was 1.42% at 30 cps; .35% at 1000 cps; and 2.78% at 15 kc. We have always felt that a harmonic distortion of 2% should be the maximum permitted for a true hi-fi power amplifier and, with that thought in mind, we found that the amplifier will produce 39.4 watts before it reaches a harmonic-distortion figure of 2% at the frequencies indicated above.



IM distortion of the "Mark IV" amplifier, taken at 60 and 6000 cps (4 to 1 ratio).

The damping factor of this amplifier was found to be 12.5.

The results of our tests proved, without doubt, that this power amplifier will provide true hi-fi performance. It is available in kit form for $59.95, or factory-wired at $79.95. [30]



Partial schematic of the "Mark IV" amplifier. Power supply, consisting of a GZ34 tube for "B+" and selenium rectifier for the fixed bias supply, is not shown here.

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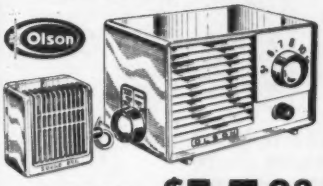

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Borg then told me that his power of memory would probably amaze me—and I had known him, while we were studying law together in Paris, to have the most deplorable memory!

So he went to the end of the dining-room and asked me to write down a hundred three-figure numbers, calling each one out in a clear voice. When I had filled the edge of an old newspaper with figures, *Borg repeated them to me in the order in which I had written them down and then in reverse order, that is beginning with the last number. He also allowed me to ask him the relative position of different numbers: for example, which was the 24th, the 72nd, and the 38th, and I noticed that he replied to all my questions at once and without effort, as if the figures which I had written on the paper had been also written in his brain.*

I was dumbfounded by such a feat and sought in vain for the trick which enabled him to achieve it. My friend then said: "The thing you have just seen and which seems so remarkable is, in fact, quite simple. Everybody has a memory good enough to do the same, but few indeed can use this wonderful faculty."

He then revealed to me how I could achieve a similar feat of memory, and I at once mastered the secret—without mistakes and without effort—as you, too, will master it tomorrow.

But I did not stop at these amusing experiments. I applied the principles I had learned in my daily work. I could now remember, with unbelievable facility, the lectures I heard and those which I gave myself, the names of people I met—even if it was only once—as well as their addresses, and a thousand other details which were most useful to me. *Finally, I discovered after a while, that not only had my memory improved, but that I had also acquired greater powers of concentration; a surer judgment—which is by no means surprising since the keenness of our intellect is primarily dependent on the number and variety of the things we remember.*

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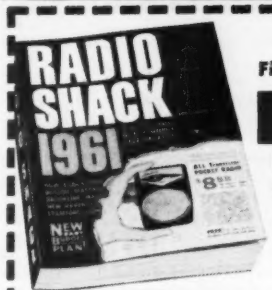

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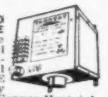

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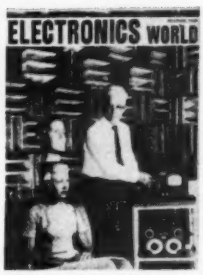

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Tube Replacement Guide (Cisin, ed.) ... 133 Mar.
Tube Substitution Handbook (Sams Staff) ..... 127 Oct.
TV Servicing Shortcuts (Kiver) ..... 100 June
2-Way Mobile Radio Handbook (Helmi). 128 Sept.
Two-Way Radio (Lytel) ..... 159 Jan.
Using and Understanding Probes (Graf). 115 Nov.
Video Speed Servicing (Marshall) ..... 128 Sept.
What Is Cybernetics? (Guilbaud) ..... 87 July
World Radio Handbook (Johansen, ed.). 105 Apr.

POWER SUPPLIES

A.C. Supply for Transistor Preamp (Steele) ..... 80 Aug.
Home-Built Power-Line Regulator (Martin) ..... 94 Feb.
Line-Voltage Adjuster (Ives) ..... 66 Nov.
Mobile Transistor Power Supply (Chayet) ..... 96 Sept.
Terado Model 5018I "Super Charger" (EW Lab Tested) ..... 145 Jan.
Voltage Regulation for Transistors (Bramham) ..... 62 July

PUZZLES

Crossword Puzzle—Electronics & Other Things (Le Fevre) ..... 127 Nov.
Electronic Crosswords (Gill) ..... 121 Apr.
Electronic Crosswords (Gill) ..... 112 June
Electronic Crosswords (Duncan) ..... 93 July
Electronic Crosswords (Balk) ..... 107 Dec.
Electronic Terminology Crossword Puzzle (Gill) ..... 98 Oct.
High-Fidelity Anagram (Comstock) ..... 30 Jan.
Name-the-Scientist Puzzle (Comstock). . 103 Sept.

TUBES & TRANSISTORS

Compactrons: Advance in Tube Design (Cover Story) ..... 48 Oct.
Don't Underrate Transistors (Spencer) .. 52 Sept.
Hi-Fi Applications of New Triode-Pentode (Austin) ..... 64 Jan.
1960 Tube Inventory for Service Shops (Barlowe) ..... 63 Apr.
Photomultiplier and Its Uses (Bukstein) . . 84 Jan.
Transistors or Tubes for Mobile P.A. Systems (Curchack) ..... 66 Jan.
Transistor Reliability (Halacy) ..... 80 Dec.
Transistor Replacement in Japanese Radios (Cover Story) (Lewis) ..... 46 Aug.
Tubes and Semiconductors—A Forecast of Sales (Martin) ..... 114 Sept.
Zener Diode Testing (Reed) ..... 57 Dec.

HIGH-FIDELITY AUDIO

AMPLIFIERS

Bass-Treble Hi-Fi Amplifier (Barkey) .... 67 May
Compact 20-Watt Hi-Fi Amplifier (Wittlinger) ..... 60 May
Design of a Transistorized Preamp (Starke) ..... 34 July
Dual 20-Watt Amplifier Kit (EW Lab Tested) ..... 60 Jan.
40- or 60-Watt Hi-Fi Amplifier with Tertiary Feedback (Burroughs) ..... 43 Aug.
Low-Distortion 3-Watt Audio Amplifier (Blum) ..... 46 Oct.
Low-Noise Transistor Preamp (Steele) . . 57 Feb.
Some Thoughts on Amplifier Design (Hegeman) ..... 69 Jan.

CIRCUITS

Class A Transistor Power-Output Circuits (Buchsbaum) ..... 55 Oct.
New Approach to Loudness Compensation (Burstein & Pollak) ..... 42 Sept.
Outboard Signal-Level Indicator (Reed) . . 39 Nov.
Preamp-Mixer for Electronic Organs Cadden) ..... 43 Nov.
Push-Pull Class B Transistor Power-Output Circuits (Buchsbaum) ..... 55 Nov.
"Reverbaphonic Sound" System ..... 82 Aug.
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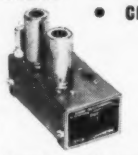

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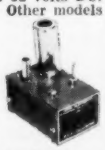

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EIA Standard for Packaged Audio Equipment .....82 Apr.
Electro-Voice Model 644 Unidirectional Mike (EW Lab Tested) .....114 Mar.
How to Choose the Proper Microphone (Riley) .....35 Sept.
Intermodulation Distortion—What it is and how it's measured (Snitzer) .....66 Feb.
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New Hi-Fi Amplifier Standards (Snitzer) ..51 Jan.
New Music-Power Rating (Editorial) .....8 June
Power Ratings & IM Tests (Born) .....58 Nov.
Report on N.Y. Hi-Fi Show (Whyte).....38 Dec.
Reverberation or Not? (Editorial) .....6 Nov.
Sound Directivity—How it is Determined (Hanson) .....33 Dec.

PHONO

Compliance of Phono Pickups (Pritchard) .34 June
Dynaco TA-12 "Stereodyne" Tone Arm & Cartridge (EW Lab Tested) .....85 Aug.
Empire 98 Tone Arm (EW Lab Tested) ..114 Mar.
Fairchild SM-1 Stereo Cartridge (EW Lab Tested) .....116 Mar.
Garrard Model 210 Record Changer (EW Lab Tested) .....107 July
Hi-Fi Record Changers (DeMotte) .....42 Dec.
Photocell Control for Phonograph (Dobbins) .....52 July
Pickering Model 380 Stereo Cartridge (EW Lab Tested) .....118 June
"Pyramid" Stylus (O'Neal) .....48 Feb.
Shure Model M232 Stereo Tone Arm (EW Lab Tested) .....123 Oct.
Shure's M212 Stereo Cartridge (EW Lab Tested) .....114 May

SERVICING

Finding Faults in Hi-Fi Systems (Fidelman) .....51 May
Low-Noise Construction Techniques for Audio (Greenfield) .....120 May

SPEAKERS—HOUSINGS

Argus Model X-4 Speaker System (EW Lab Tested) .....84 Aug.
Audax CA-60 Speaker System (EW Lab Tested) .....109 Sept.
"Bi-Phonic Coupler"—Unique Hi-Fi Speaker System (Cohen) .....45 May
Home-Built Acoustic-Suspension-Type Speaker System (Hughes) .....62 Sept.
Homewood Model 2 Speaker Enclosure Kit (EW Lab Tested) .....110 Sept.
"Knight" KN-3000 Shelf-Type Speaker System (EW Lab Tested) .....122 Feb.
University T-202 "Spherican" Tweeter (EW Lab Tested) .....84 Aug.

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Dual 14-Watt Stereo Amplifier (Voss) ..48 Nov.
Dynakit Model PAS-2 Stereo Preamplifier (EW Lab Tested) .....71 June
Eico Model AF-4 Dual 4-Watt Stereo Amplifier Kit (EW Lab Tested) .....124 Feb.
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Harman-Kardon "Citation II" Stereo Power Amplifier (EW Lab Tested) .....70 June
Heath Model AA-50 Integrated Stereo Amplifier Kit (EW Lab Tested) .....122 Oct.
Integrated Stereo Preamp-Amplifiers (DeMotte) .....51 Oct.
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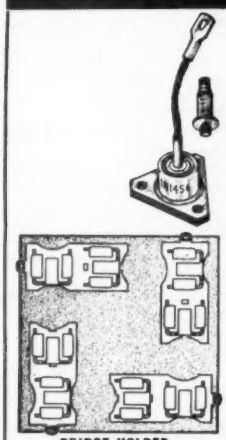

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Please see ad, bottom page 111, Sept. issue of this publication. A great Christmas buy and only $14.95 down & 12 payments of $12.33/mo. on Time Pay Plan.

LOOK! $49.50 BUYS AN APR-4 RECEIVER!

AN/APR-4 Receiver Unit, ready to accept plug-in tuning units from 38 to 4000 mc. This is the 30 mc I.F. ampl. with choice of 0.6 or 2 mc pass band, for communications or for Noise & Spectrum analysis. Has built-in 120 v, 60 cy power supply. Panadapter output. Video output. Phones outputs. S-Meter, BFO, and Volume control. DO NOT CONFUSE with the much earlier model APR-1; this is APR-4! In apparently EXCELLENT condition (visual inspection) **$49.50**

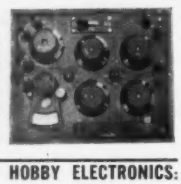
less tuning units, fob Los Angeles.....

Add $45.00 for TN-16, 17, 18/APR-4, tune 38-1000 mc.

TEST OSCILLOSCOPES AT $39.50 AND UP!

Please see ad page 111 Nov. issue this publication for two ready-to-use $39.50 scopes; Oct. ad page 120 for scope with response to 8 mc (DS-4B); and write for details on DuMont ≠256B and ≠294A.

0.1% ACCURACY WHEATSTONE BRIDGE



For DC resistance, but the 4-dial rheostat arm can also be used as a decade box 0-10, 110 ohms. Ratio dial X.001, X.01, X.1, X1, X10, X100. Compact, self-contained. Built-in galvanometer and battery compartment. Guaranteed 100% OK. We measure precision resistors before shipping. Only **$109.00**

BARGAINS IN LAB & HOBBY ELECTRONICS:

Please see Nov. ad page 111 for VHF Communicator, like new, only $49.50; for high-power xmtr power supply and volume-compressing speech amplifier, all for $14.95; for VHF Microvolter signal generators; for pulse generator; for NBFM Microvolter signal generator; for Geiger counter; for low-frequency tuning fork oscillators with phenomenal accuracy; for a compact scope xfrmr at $6.95; for an Xmtr, CW/-MCW AM or TTY that emits two separate messages simultaneously, each with 400 watts to antenna. Please see our Oct. ad page 120 for wonderful buys in General Radio test equipment; H.P. 100-D Low Freq. Standard; Stoddart Interference & Field Strength meter; Meas. Corp. inter-mod. analyzer; Brush and G.E. graphic recorders; 130-amp DC power supply. Our ads are Buyers' Guides to the best in Surplus.

0.1% SORENSEN Line Voltage Regulator

≠5000S. Brand new at low surplus price! Input 95-130 V, 1 ph., with taps for 50 or 60 cy. Use for any power up to 5000 watts. Output adjustable 110-120 V and holds to ±0.1% at line frequency, or to ±0.25% if line frequency drifts 5%. Regulates against line changes of 95-130 V and against load changes from 0 to 5 KVA. Maximum harmonics less than 3%! Recovery time 0.15 seconds. Input to the control section can be moved to the point where you will use the power, thus compensating for line drop. In rack cabinet 28" h, 22" wd, 15" dp. Net wt 190 lbs. Shpg wt 285 lbs FOB Utica, N. Y. In original factory pack suitable for export, including SPARE PARTS group. Sorensen catalog net price is $695.00 less spares. Our price, WITH SPARES **$349.50**

It is smart planning to buy this 5 KVA capability even if your present need is for lower power, because: 1. It works just as well at lower power. 2. Price is as low as a 1 KVA unit! (Sorensen's prices, LESS SPARES, are $320.00 for 1 KVA, $480.00 for 2 KVA, $520.00 for 3 KVA, and $695.00 for 5 KVA.)

WRITE FOR DETAILS ON OTHER C-V UNITS

Raytheon unit has harm. filter, output 115 v ±½% at 7.1 A and 1 other fixed load,$49.50. Following units regulate for any within ratings: Superior servo-driven Powerstat, 1.2 KVA, $125.00, and 2.5 KVA $150.00; no harmonics in either. Sola 1 KVA at $75.50, 2 KVA w dual input $167.50. 3 KVA w/dual input and output $167.50. G.E. 2.3 KVA $49.50.

SCHEMATICS/CONVERSIONS, SURPLUS GEAR

Ask us for your needs: send stamped addressed envelope. Add 25¢ for chart explaining AN Nomenclature. Examples of available literature: 20-page book on 1-177, with diagram of MX-949/U socket adapter, & tube data compiled to March 1957, $5.00. RT-18/ARC-1 schem. & tune-up instr. $2.00. MAR. 22 pages & 5 large pullout schematics. $5.00.

Calif. buyers please add 4% when remitting.

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Stereo Microphone Techniques (Burstein) .....66 Mar.

TAPE RECORDING

Bulk Eraser for Magnetic Tape (Wolfson) .....130 Oct.
How To Make Better Tape Recordings ..110 Feb.
Measuring Tape Speed (Burstein) .....38 June
Multiplexing Music with One Recorder (Shaw) .....42 Apr.
Norelco Stereo "Continental 400" Tape Recorder (EW Lab Tested) .....106 July
1⅞-ips Tape System for Stereo (Snitzer)..36 June
Record Live Stereo at Home (Crowhurst)..34 Aug.
Tape's Progress—A Status Report (Burstein) .....38 July

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Indoor Antenna—Outdoor Design .....98 May
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New Antenna Rotator (Greenberg) ....112 Jan.
TV Fringe Antenna Selection (Darr) ....54 May

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Britain's New TV Center (Halliday).....75 Dec.
British TV Changes Looming (Halliday) .....133 Sept.
"Grounds" for Confusion (Gary) .....70 Jan.
Hams, TVI, and Technicians .....90 Aug.
How a Pool Telecast Works (Moss) ....54 Jan.
Newfoundland's Microwave TV Network (Jarman) .....54 July
New TV Designs for 1960 (Buchsbaum) ..44 Mar.
19-inch Transistor TV .....70 July
1961 British Trends (Halliday).....113 Dec.
R.F.—Is It Dangerous? (Hubelbank) .....45 Apr.
Service in 1959 .....54 Apr.
Thermoplastic Recording .....47 Mar.

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Cascode Circuits: How and Why (Kyle) ..66 Sept.
De-Bugging the Horizontal Oscillator (Smith, W. J.) .....60 Feb.
Finding Filter Faults (Bramham) .....44 Nov.
Fusing TV Tuners (Mitnaul) .....33 July
Horizontal Deflection Circuits (Bramham) .....52 Jan.
Intermittent Vertical Sync Problems (Heller) .....72 Oct.
Mac's Service Shop (Frye) .....60 Dec.
Odd Sort of "Tube" Problem (Philpott) ..64 Mar.
Pix Tube as Tuning Eye (Martin) .....46 July
Service Notes .....82 Jan.
Service Notes .....32 Feb.
Ultrasonic TV Remote Controls (Feingold) .....54 Aug.
Why "Dogs" Are Tough (Webster) ....54 Nov.

TEST EQUIPMENT

AMATEUR

Grid-Dip Meter (Dezettel) .....50 Dec.
Resonance Meter (Reiffin, W5CWP) ....94 Jan.
Transistor Audio "Q" Multiplier (Stone) .....124 May

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Simple Audio Distortion Meter (Graham) .....57 Apr.
Simple Audio-Distortion Tester (Henry) .....120 Mar.
Sweep Generator for Hi-Fi AM (Stoner) ..50 June

AM-FM

Automatic Range-Selecting Circuit for V.T.V.M. (Ratliff) .....116 Apr.
Calibrated Decade Amplifier (Jaski) ....68 Apr.
Capacitance Solver (Stoner, W6TNS) ....66 May
Capacitor Tester & Healer (Lieberman) ..52 Apr.
Dynamic Capacitor Checker (Wrigley) ..40 July
Improving A.C. Voltmeter Accuracy (Duguid) .....116 Aug.
Low-Ripple Adapter (Meyer) .....56 May
Practical Transistor Tester (McCarthy, K6EAW) .....80 Mar.
R-C Substitution Box (Damico) .....60 July
Transistor "Alpha Box" (Stoner) .....86 Nov.

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Check Power Output, Standing Waves *Cesco* Transicheck. Gives meter indication of power output, VSWR. Ideal for transmitter tuning. Specify auto spade or PL-259 type coax connector. **$20.95** Postpaid

Eliminate Generator Whine

Cesco Generator Filter. Eliminates generator whine in mobile installations. Tunable for maximum attenuation. Most effective generator noise filter made. Also available for other frequencies. Postpaid **$3.00**

Cesco Duopole Base Antenna

Rugged, tuned CB antenna with 1 to 1 VSWR. High gain, non-directional. All elements at DC ground potential for maximum lightning protection. Also available for other frequencies. **$29.95** Shipped Express Collect

Send check or M.O. Ohio residents add 3% Sales Tax.

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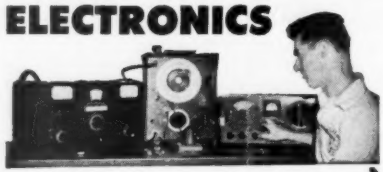

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Transistorized Square-Wave Shaper (Lederer) ..... 82 June
Troubleshoot Your Own V.T.V.M. (Anderson) ..... 116 Feb.
Vibrator "Washer" (De Bra) ..... 82 Sept.
Wide-Band A.C. Millivoltmeter (Sharpe) .. 58 Jan.

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Measurement of Meter Resistance (Gerstle) ..... 82 July
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Solder-Gun Temperature Control (Vogelgesang) ..... 53 Aug.
Square-Wave Voltage Calibrator (Shields) ..... 99 Nov.
Technicians & Test Equipment (Editorial) .. 6 Dec.
Transistorized Instrument Preamplifier (Caringella) ..... 72 Aug.
Transistorized Tachometer Pickup (Lederer) ..... 88 Aug.

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TV Remote-Control Aligner-Tester (Hadrick) ..... 68 Sept.
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Answer to Puzzle Appearing on Page 107

W	A	V	E		G	R	A	M		C	R	O	W	
W	I	E	N		L	U	M	E	N	H	A	H	A	
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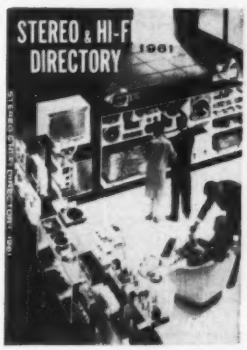

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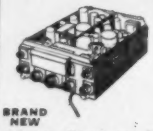
FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC



BRAND NEW

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc. citizens radio 460-470 mc, fixed and mobile 450-460 mc. television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.

Shipping weight 25 lbs. **SPECIAL!** **$19.50**

PE-101C Dynamotor, 12/24V input	$7.95
UHF Antenna Assembly	2.45
Complete Set of 10 Plugs	5.50
Control Box	2.25

SPECIAL "PACKAGE" OFFER:

BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE, BRAND NEW, White Stocks Last **$29.50**

BC-929 3-INCH SCOPE

Low cost station monitor and/or bench scope. Has Horiz., focus, sweep, intensity controls. Tubes: 2—6SN7, 2—6H6, 1—6X5, 1—6G6, 1—2X2, 3BP1 CR Tube. Voltage req. 115V 400 cy. and 24 VDC. Complete with tubes, exc. used **$9.95**

BRAND NEW **$12.95**

Conversion Instructions for 110V 60 cyc. AC .. **65c**

LORAN R-65/APN-9 RECEIVER & INDICATOR

Used in ships and aircraft. Determines position by radio signals from known amitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used. **Value $1200.00. Our Price** **$79.50**

Used, less tubes, crystal and visor, but with 3BP1 C.R. tube **$29.50**

12 Volt Inverter Power Supply for above. BRAND NEW **$32.50**

28 Volt Inverter Power Supply, exc. cond.	$49.50
Shock Mount for above	$2.95

Circuit diagram and connecting plugs available. We carry a complete line of spare parts for above.

LORAN APN-4

FINE QUALITY NAVIGATIONAL EQUIPMENT

Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.

INDICATOR ID-68/APN-4, and RECEIVER R-98/APN-4, complete with tubes. Exc. used **$49.50**

Receiver-Indicator as above, BRAND NEW **$88.50**

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Shock Mount for above	$2.95

We carry a complete line of spare parts for above.

ARC-5/R28 RECEIVER

2-meter Superhet. 100 to 156 Mc in 4 crystal channels. Complete with 10 Tubes. **BRAND NEW** **$24.45**

110V AC Power Sup. Kit for above **$9.75**

ARC-5/T-23 TRANSMITTER

100-150 Mc Includes 2—832A, 2—1625 Tubes. **BRAND NEW** **$21.50**

SPECIAL OFFER! Limited quantity ARC-5/T23 xmitters. Excellent Used, less tubes **$5.95**

MD-7 MODULATOR for T-23, complete with 4 tubes. LIKE NEW **$9.95**

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Navy Type Comm. Receiver 1.5 to 3 Mc BRAND NEW with 6 tubes **$16.95**

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MODULATOR for above, new with tubes **$5.95**

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 Mc	10.45	12.45
BC-455	Receiver 6-9 Mc	11.50	13.95
BC-450	3-Receiver Control Box	1.29	1.75

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions **$7.95**

Factory wired, tested, ready to operate **$11.50**

SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. **Only** **49c**

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal, BRAND NEW .. **$8.95**

BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW **$9.75**

BC-459 TRANSMITTER—7-9.1 Mc. complete with all tubes and crystal **$13.95**

BC-456 Modulator	USED 3.45	NEW 5.95
BC-451 Transmitter Control Box	1.25	NEW 1.49

ALL ACCESSORIES AVAILABLE FOR COMMAND EQUIPMENT.

EE-8 ARMY FIELD PHONES. Excellent condition checked out, perfect working order, complete with all parts & battery. Each **$12.95**

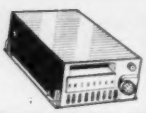
WILLARD 6-VOLT MIDGET STORAGE BATTERY

3 Amp. Hour. **BRAND NEW.** 3⅝" x 1-13/16" x 2⅝". Uses Standard Electrolyte ..... **Only $2.95**

2 VOLT BATTERY "PACKAGE"

1—2V, 20 Amp. Hr. Willard Storage Battery, Model 220-2. 3" x 4" x 5⅛" high	$2.79
1—2V, 7 prong Synchronous Plug-in Vibrator	1.49
1—Quart Bottle Electrolyte (for 2 cells)	1.45
ALL BRAND NEW! Combination Price	**$5.45**

ARC-3 RECEIVER!



Complete with All Tubes Exc. Used **$16.95**

Like NEW $21.50

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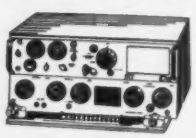
ARC-3 TRANSMITTER

Companion unit for above, tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes: 3-6V6, 2-832A, 1-12SH7, 1-6J5, 2-6L6. Exc. Used ..... Only **$16.95**

Like new condition $22.50

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc



$48.50

Complete with Tubes

Famous Collins Autotune Aircraft Transmitter, AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811s modulate 813 in final up to 90%, class "B." A Real "HOT" Ham buy at our low price! Orig. cost $1800. Exc. Used **$48.50**

0-16 Low Freq. Osc. Coil for ART-13	7.95
24V Dynamotor for ART-13	11.95
Same as above less meter	39.50

We carry a complete line of spare parts for above.

POWER SUPPLY for BC-620, 659, available for 6, 12 or 24 Volts DC. Specify **$8.95**

BC-659 TRANSMITTER & RECEIVER

27 to 38.9 Mc. F.M. Two preselected channels crystal controlled. 5 watts. Complete with speaker, tubes. Used **$10.95**

Less tubes, used $5.95

Antenna for BC-659. Telescoping 20" to 8-Ft. $2.95

NAVY AIRCRAFT RADIO RECEIVER

ARB/CRV 46151—190 to 9050 Kc in 4 bands. 6 Tube Superhet communications receiver, with local and remote tuning, band change. Sharp and broad tuning. AVC, CW. Illuminated dial. Complete with tubes and dynamotor. BRAND NEW **$34.50**

Like New $26.50

Power Supply 110 V. AC. Wired **$8.50**

BC-906 FREQ. METER—SPECIAL

Cavity type, 145 to 235 Mc. BRAND NEW, complete with antenna. Manual included. OUR LOW PRICE **$10.88**

SCR-625 MINE DETECTOR

Complete portable outfit in original packing, with all accessories. Brand New **$22.50**

DYNAMOTOR ASSEMBLY

Very fine unit, made by Collins Radio. Consists of TWO Dynamotors mounted on filter base.

Dynamotor #1 INPUT	OUTPUT
12VDC @ 3.8A	220VDC @ 100 Ma.
Dynamotor #2 INPUT	OUTPUT
12VDC @ 9.9A	400VDC @ 180 Ma.

BRAND NEW, in original packing.

shpg wt 29 lbs. **OUR LOW PRICE** **$10.95**

MOBILE-MARINE DYNAMOTOR

Model DM35

Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs. OUR LOW PRICE. BRAND NEW.. $8.45

OTHER DYNAMOTOR VALUES: Type	Input	Output	Excellent Used	BRAND NEW
DM-25	12V 2.2A	250V .050A		$4.50
DA-1A	28V 1.6A	230V .100A		3.25
DM-28	28V	224V .07A	2.75	4.75
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A 28V 7A	575V .16A 540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-53A	28V 1.4A	220V .080A	3.75	5.45
DM-64A	12V 5.1A	275V .150A		7.95
PE-73C	26V 20A	1000V .350A	8.95	14.95
PE-86	28V 1.25A	250V .050A	2.75	3.85

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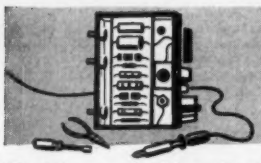

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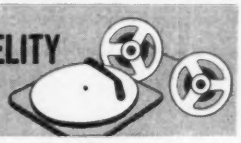

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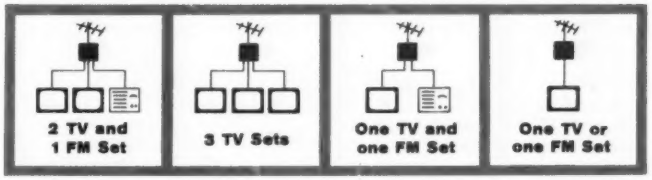

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Reprinted from PF Reporter, inside front cover, Sept. 1960

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